# AQUARIAN NATURE STUDIES

Albert Gale

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# AQUARIAN NATURE STUDIES

# Aquarian Nature Studies

AND

## Economic Fish Farming

BY

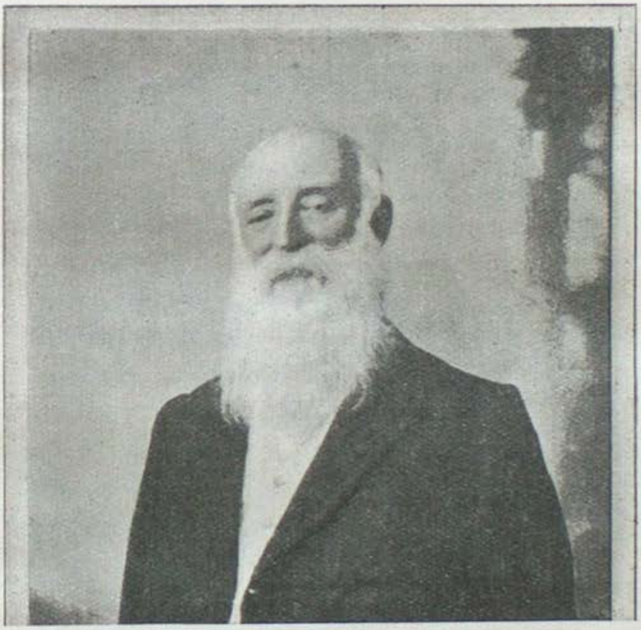
ALBERT GALE

Author of
"AUSTRALIAN BEE LORE AND BEE KEEPING.'

Published by Authority.

To

JAMES DAWSON, M.A.



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# INTRODUCTORY NOTE.

Mr. Albert Gale, the author of this little book on Aquaria, is well known in New South Wales, and indeed in Australia, as a patient investigator of the ways of bees and the tiny denizens of our ponds and rivers. In spite of his eighty years, his interest is unflagging, and his desire to awake similar interest and delight and admiration in others continues unabated. He reminds me of that other octogenarian, M. Henri Fabre, who in recent years has charmed us with his studies of insect life.

The little book should be a help to teachers and others in a most delightful form of Nature Study—a form which leads to the beautifying of the home and the school. There are, too, very useful suggestions for the " man on the land " who wishes to make a profitable use of the creeks and waterholes thereon.

J. DAWSON

Sydney, 2nd *March*, 1915.

# AUTHOR'S PREFACE.

THE great and growing interest that has during the past few years manifested itself in the study and love of Nature among the students of our primary schools, and the ardent desire among the teachers to look down below the surface of living things, and search out the "why" and "how can these things be," induced the author of this little volume to publish some of the information gleaned by the personal use of his eyes in watching the movements and habits of fish and some of the lower animals met with in Aquaria.

Where is the student who has not longed to know the enigma, the intricate and the secret counsels, of the beginning of life, and how the tiny seed receives the germ of the mighty trees, the beautiful flowers and the plants that give us our daily bread, and who has seen the roes of fishes and has not wondered how their sand-like grains can give us the great fish of our rivers and seas?

Mr. Ruskin says, "The more I think of it, I find this conclusion impressed upon me, that the greatest thing a human soul ever does in this world is to see something and tell what he saw in a plain way." This has been the author's sole aim in this little volume, and as far as possible he has only told what he has seen in nature.

Nature is a great book, and will always open her pages to those who are anxious to look through them. The author has always made of her one of his chief companions. From boyhood he longed to learn of Nature from Nature. He will be forgiven when he says that too many of the lessons on natural history given to children in schools are uninteresting because they are bookish, and more or less second-hand. He found it so in his teaching days. He saw, too, the great interest shown by a class when it learned that the primary aim of all organisms was the search for food, and the continuation of its representatives.

It will be understood that this little volume refers only to the inhabitants of fresh water.

Stanmore, Sydney,
September, 1915.

ALBERT GALE.

THE full-plate illustration on the opposite page is a vertical section of an Australian ordinary waterhole, such as is to be met with in all parts of the continent. It is illustrative of one of Nature's aquaria, delineating some of the indigenous aquatic plant-life, fishes, molluscs, &c., that are to be found wherever there is permanent water; these accessories are adaptable for aquaria and the stocking of artificial waterholes for economic fish farming.

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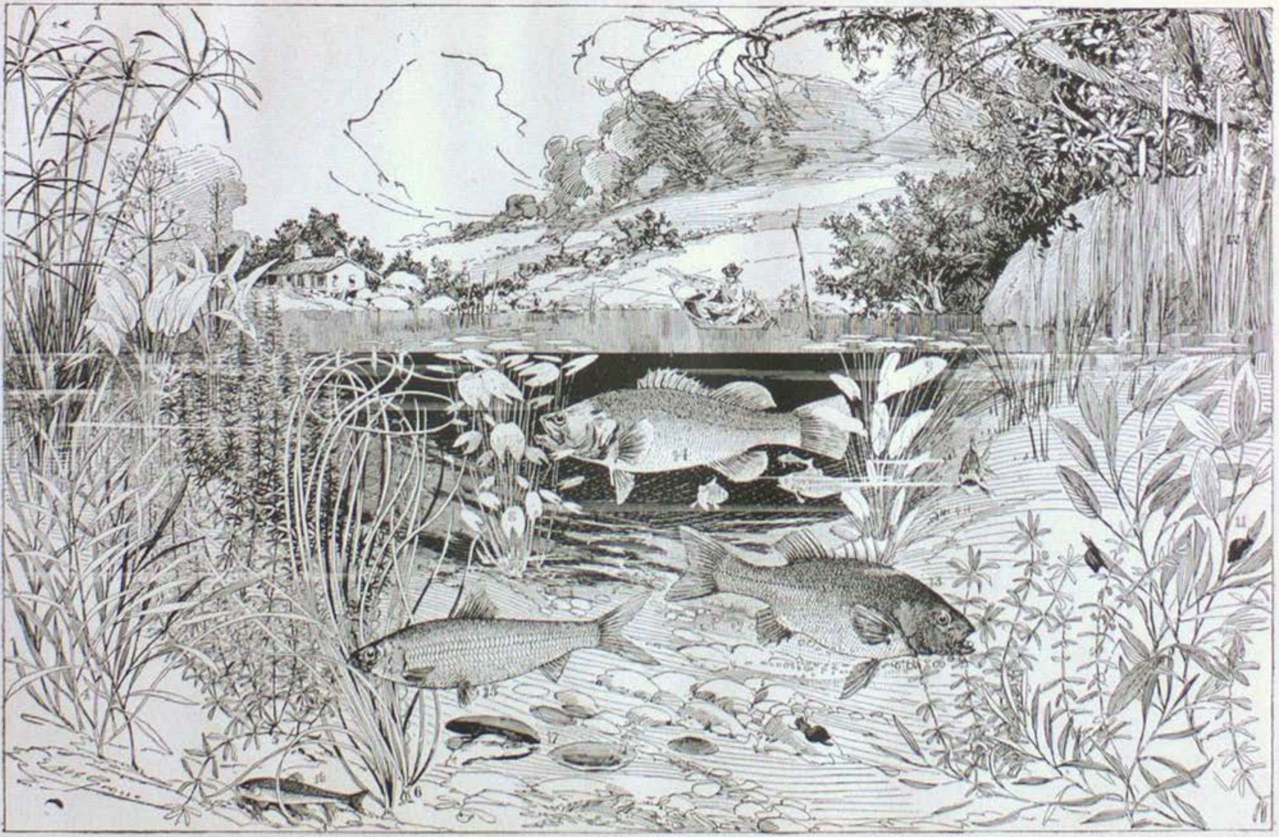

Section of an Australian Waterhole

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# INTRODUCTION.

## AQUARIA AND THEIR INHABITANTS.

### NATURE STUDIES AS HOBBIES.

Hobbies—Aquatic Gardens—The Three Kingdoms of Nature in a bottle.

A PERSON with a domestic hobby is always a lover of home. A pastime is that which makes judicious use of time otherwise unoccupied. True leisure is that which tends to health and strength in both body and mind. It is not only a benefit to the individual, but also to the community. We cannot benefit ourselves mentally but some one or other will be sure to reap a reward from our mental culture.

An aquarium is a little physical world in a bottle. It should, nay, must, contain specimens of the mineral, the vegetable, and the animal kingdoms. If these kingdoms be not represented in an aquarium in a greater or lesser degree, especially the vegetable, then the health, nay, the beauty, of the animal life cannot be maintained in all its vigour. We are told it took six days to prepare these three kingdoms before the earth was in suitable condition for the Creator to place his pets in. Our little world will take more than six days before it is sufficiently matured for our purpose.

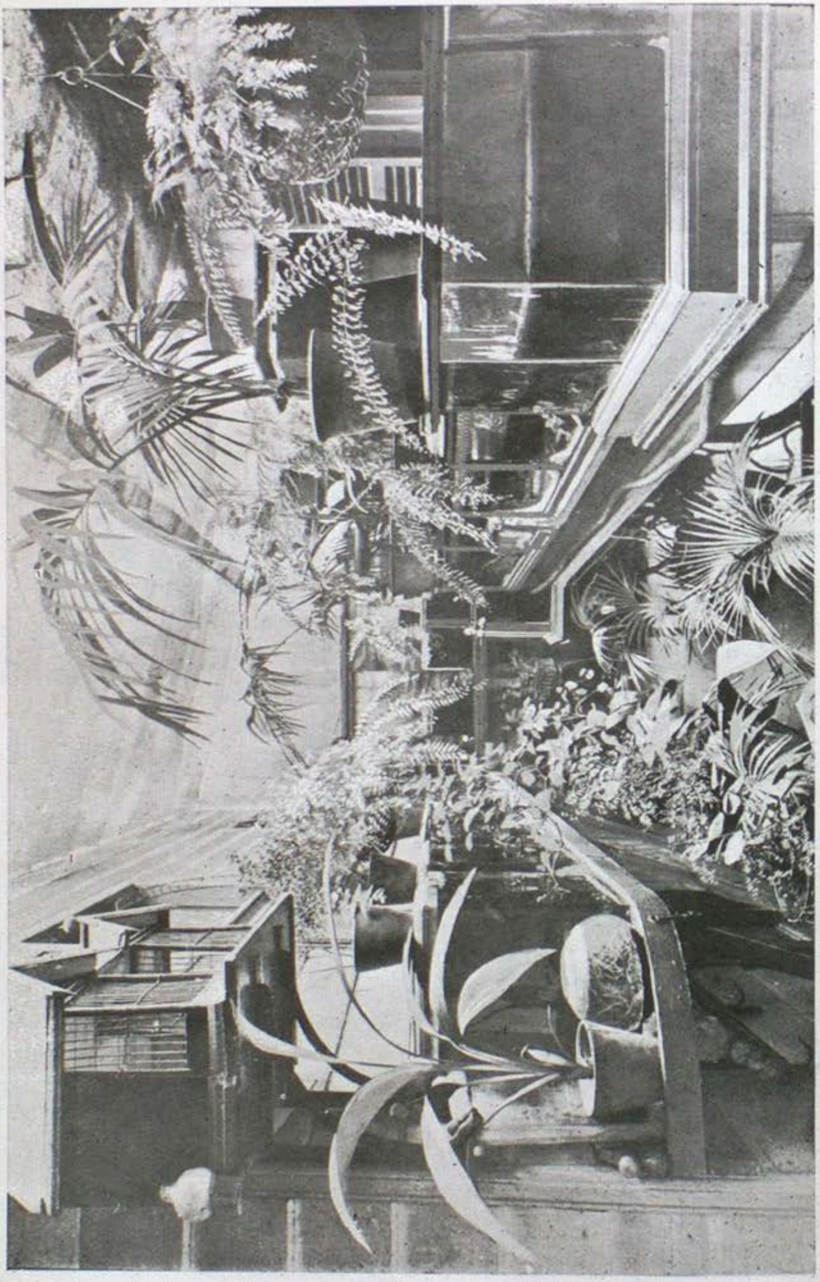
The research in collecting aquatic specimens adaptable for our hobby is a continuous round of exciting interest. Every excursion along the banks of rivers, creeks and waterholes is a health-giving tonic. No aquarium in its fitting up has been completed in six weeks, let alone six days. There will be many failures before success can be achieved. Sunlight and shadow are the things life is made of. Wisdom taught is far more valuable than wisdom bought. We take a greater pride in what is self-acquired than in that learned by second-hand instruction. The knowledge of the ways and habits of Nature obtained in the open air is a thousand per cent. more valuable and more lasting than that obtained from dried and stuffed specimens with book lore thrown in. Nevertheless, don't despise these, they are all valuable as addenda to research and collecting from Nature the things required to perfect our little world in a bottle.

Where is there a more valuable compendium of organic nature than that furnished by an aquarium ? Nature wrote it, and she makes no mistakes. An aquarium well fitted up with specimens of vegetable and animal life, properly watched and tended, cannot be rivalled by books of man. No observer of Nature's works has ever collected and given to the student in bound volumes such details of her handicraft as can be read in an aquarium.

When the vegetable world is reproducing her species it is then she arrays herself in exquisite beauties—her blossoms and flowers. So it is in the animal world, especially with fishes. In some species the jealousies and watchfulness of the males for their progeny are not excelled by the feathered world. True, some species of fish are wholly cannibalistic, and greedily devour their own offspring, even in the ova stage, to wit, goldfish (*Carassius auratus*).

An aquarium, as regards its plant life, should be an aquatic garden. The specimen plants must of necessity be submerged. Their inflorescence is of the most inconspicuous hues. Foliage that is developed on or above the water does not oxygenate it. Plants growing in a healthy state are constantly liberating oxygen. It is the inhalation of this gas that sustains a healthy vigour in fish and other animal life. The carbonic acid gas thrown off by the fish is the health of the plants. The chemistry of aquaria is an interesting study. I am supposing you know nothing of the subject. Nature studies are now occupying a prominent place in the school curriculum. Let us fit up an aquarium by beginning at the beginning.

Get your cage before you get the bird, is a very old proverb. An aquarium must be so constructed as to enable the observer every facility for watching its inhabitants. The scientific studies must not be confined to the fishes. There are the " hundred and one " inmates that will need the patience of the keenest observers to learn their life-history. The most minute details are those that give the greatest amount of interest, and therefore wisdom to the disciples of old Dame Nature. No hard and fast rules for the size of an aquarium can be given. If the aquarium be meant as a decoration for the drawing-room window, it will admit of any amount of originality in its ornamentation. Guard against globular forms. The inmates in such are never seen true to life. They always assume a more or less grotesque and distorted shape. The space at your disposal in which it is intended to establish your fish-tank must be the guide for all its measurements.



Author's Aquaria, looking north.

# Chapter I.

## AQUARIA.

Various Designs of Aquaria--Aquaria Measurements—(*a*) Receipts for Repairs; (*b*) Covers or Lids.

Fish are placed in aquaria for the purpose of observation and therefore pleasure. The aquaria should be arranged so that the details of every movement of the animal can be easily observed. A tank must have three measurements, length, height and width. It may be any reasonable height and the same as regards length. Not so as regards width; this should not exceed from 12 inches to 15 inches in any aquarium. The greater the body of water to see through, the more obscure the object under observation. The longer the tank the greater the necessity for it to be made in panels.

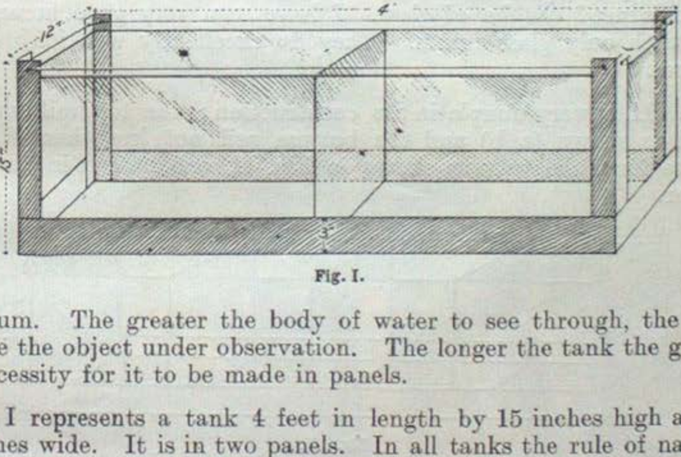


Fig. I.

Fig. I represents a tank 4 feet in length by 15 inches high and is 12 inches wide. It is in two panels. In all tanks the rule of narrowness must be observed. If they be made thus, there is less danger of breakage; and it is cheaper to repair them.

Here is another rule. The top rails and uprights may be made of 1¼″ stuff, if wood; if made of zinc they may be lighter and therefore neater. The smaller the tank the less strength is required in the frame. Nevertheless, in all large tanks the bottom rails should be at least 4 inches deep. The reason is obvious; should an accident happen to the glass there would be water enough left in the tank formed by these deep rails to save the lives of both fish and plants until the accident is discovered and repaired.

Fig. II is a cheaply made 5-foot panel tank; the ends are of wood or slate, and if the bottom be of slate so much the better. American redwood is one of the best timbers wherewith to construct an aquarium.

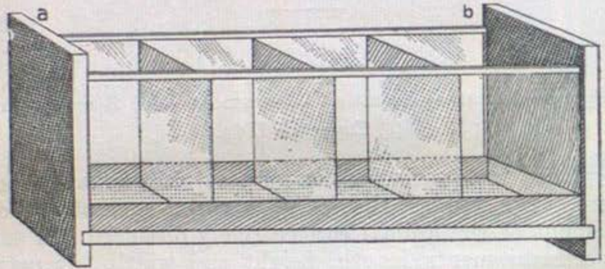


Fig. II.

It is easily worked and is more durable than any other soft wood. The ends need not be of glass. I have seen very good home-made tanks with only glass fronts. They do excellently well for breeding purposes.

Fig. III is very simple in its construction; the top rail must be placed as shown (a b) and the bottom rail not less than 4 inches deep to form the tray as shown in Fig. II, and braced in the same manner.

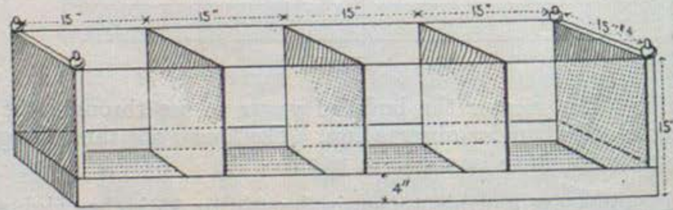
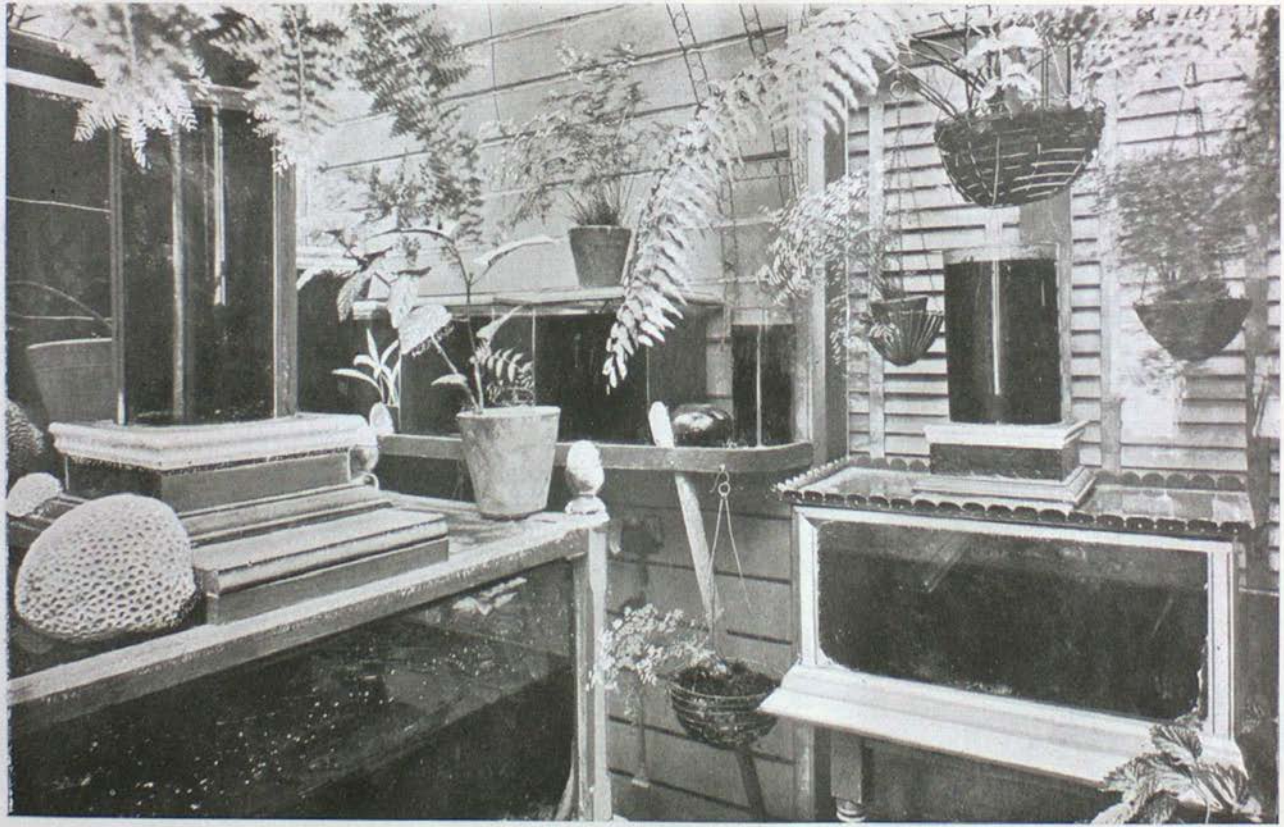


Fig. III.

For small aquaria the obsolete electrical accumulating jars cannot be surpassed. They never leak. They are of various sizes. Those in general use measure 13″ x 11″ x 13″. In selecting choose those having the clearest glass.

For aquaria that are to be fixtures, those built of cement concrete are to be preferred. The ends and floors are grooved to receive the



Author's Aquaria, looking west.

glass or slate sides. Large sides of plate glass are dangerous on account of breakages. In long tanks the sides should be panelled. When the frames are put together, paint the angles and grooves with black sapolin, at the same time paint the edges of the slate or glass. When this is dry, give a second coat. While the enamel is still wet, place the ends and sides in position. Finally put another coat of enamel over the joints and paint to taste.

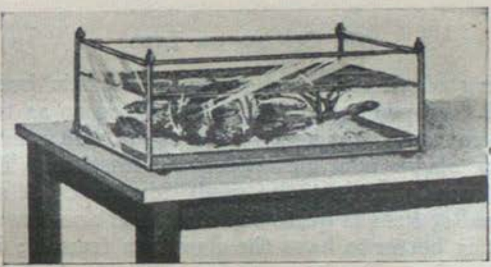


Fig. IV.

Fig. IV is a small portable tank suitable for protecting the young fry when newly hatched. The water supplied thereto should be taken from the tank wherein they were hatched. Such water contains animalculæ.

### (*a*) RECIPES FOR REPAIRS.

A cement for embedding both slate and glass can be made by mixing red and white lead together to the consistency of putty, well working it into the joints. Portland cement is a good substitute. The best of all is that used for fitting rubber tyres on bicycles. It must be well melted to flow easily where required. Tilt the tank at an angle so that the melted cement will flow along the groove or angle. Remember it dries very quickly.

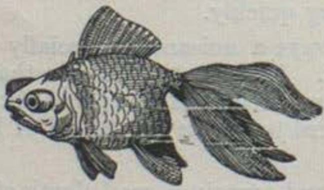
A leaky tank is always a nuisance, especially so when it is in a drawing-room window. Here is an old recipe that has always proved good: one part of finely sifted sand, one part of litharge, one-third part of powdered resin, mixed to a paste by the aid of boiled oil; this never fails to stop leaks.

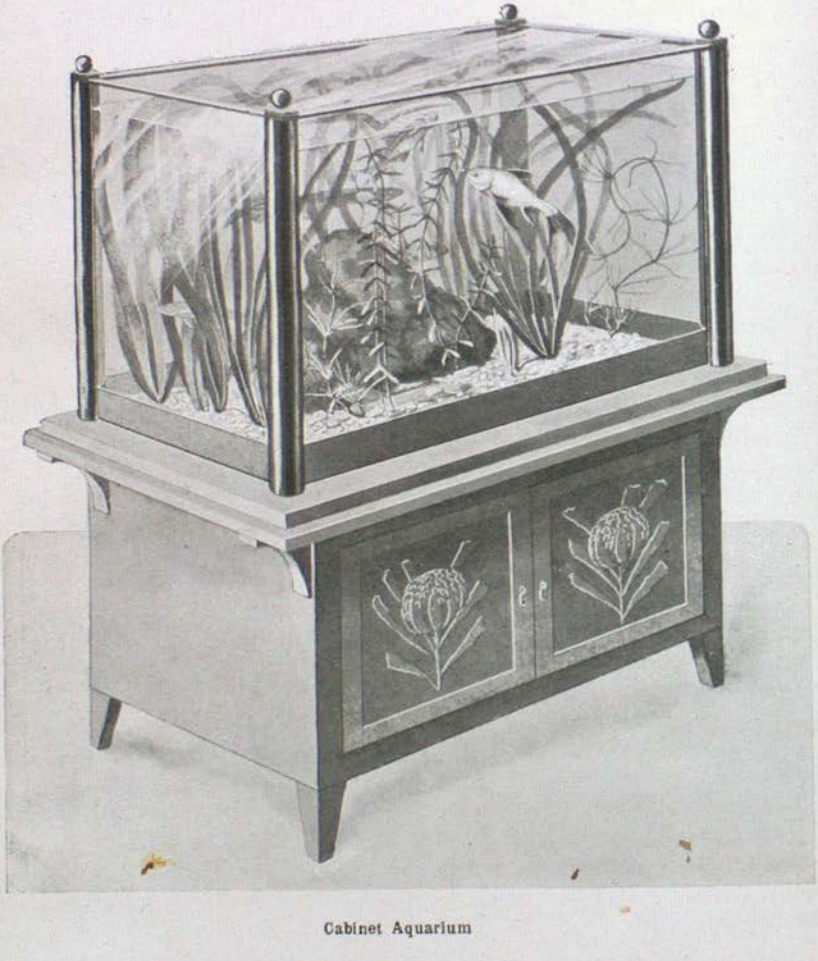
If the tank be high and contain a good depth of water, it will sometimes leak at the joints. Lower the water till it is below the leak. When dry paint the aperture with sapolin, and when this is dry give another coating. This enamel quickly sets.

Accidents will happen to the best regulated homes. An aquarium is no exception to the rule. A crack athwart the glass front is always more or less unsightly. Another thing, it is always weeping. A crack in glass expands and never contracts; if it be in a drawing-room so much the worse. To save trouble and time, do this: when the glass near the crack is dry on both sides paint it over with enamel paint, and while the enamel is still wet with the paint take a narrow strip of tape or silk; coat this with some of the enamel and place it over the crack on the inner side, pressing it firmly. I have secured many a crack with only enamel paint and never found it again to leak.

### (*b*) Covers or Lids.

In the making of all sizes and forms of aquaria keep in view the necessity of all the open tops being constructed so as to receive some kind of a glass covering. It keeps all dust out and prevents children's fingers and cats' claws from disturbing the inmates. The glass cover must be fitted loosely so as to be easily removed. A simple sheet of glass on the smaller sizes is quite sufficient and answers every purpose. Nevertheless it is better to have the glass lids framed; it looks neater and the glass is safer. Don't run away with the foolish and common idea that a glass cover excludes the air from the water and thereby deprives it of the life-giving oxygen. It is a mistake to think that fish get their supply of oxygen from the surface of the water. It is a sure sign the tank is in an unhealthy condition when the fish are seen swimming on the surface and frequently inhaling atmospheric air. It is the plant life when in a vigorously growing condition which does all that is required to oxygenate the water.





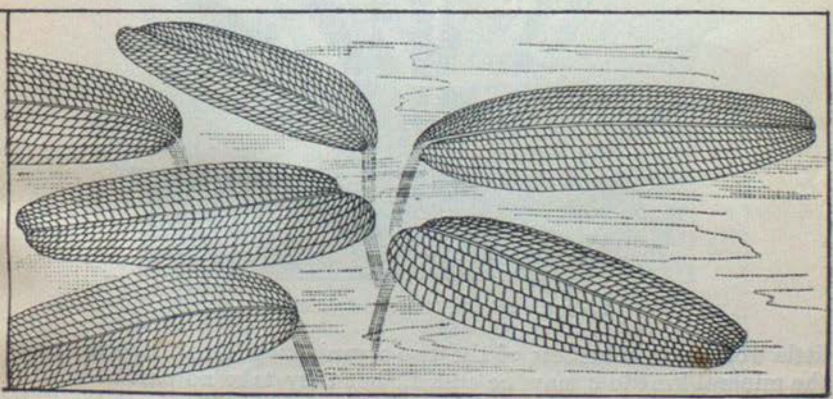
Cabinet Aquarium

# Chapter II.

## AQUARIA PLANTS.

Vallisneria Spiralis—Lattice or Lace Plant—Spiked Water Milfoil—Potamogeiton—Nitella—Canadian Water Weed—Duck-weeds—Azolla—Uses of Aquatic Plants.

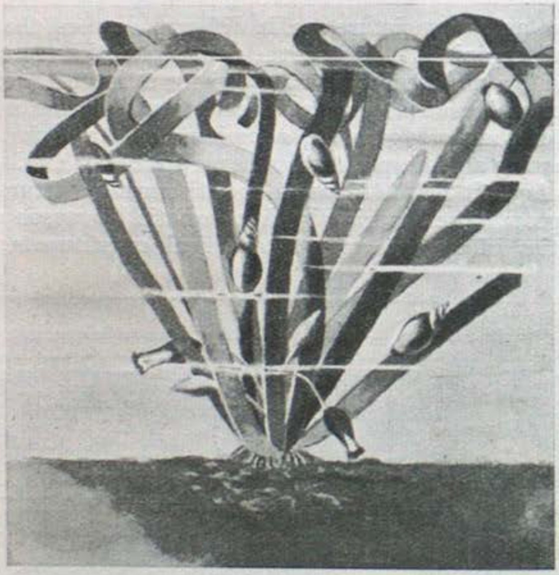
Light, heat, air and moisture are, in different degrees, the health and strength of all organic life, both in the animal and the vegetable world. Carbonic acid gas and ammonia and water form the sole food of plants. True, there must be an accumulation of humus forming a stratum in which most of the herbage of an aquarium must root for anchorage. There are floating aquatic plants that never search for much anchorage, duckweed. Aquatic plants of larger growth must be fixtures. Terrestrial plants grow more luxuriantly than aquatic by reason of the physical properties of humus and its chemical constituents; these are supplied by the decomposition of organic matter and the carbonic acid gas exhaled by the living members of the animal kingdom. They give health to the plant world.



**The Lattice or Lace Plant (Ouvirandra fenestralis).**

As light, heat and moisture, in different degrees give health and life, and carbonic acid gas forms most of the food of plants, so light, heat and oxygen are the mainstay of the animal kingdom. Aquatic plants set free the oxygen gas which is inhaled by the animals contained in the aquarium; the latter in their turn set free carbonic acid gas, which is inhaled by the plant life. There is a constant circulation of these two gases between animal and vegetable life. These keep your pets in perfect health and strength.

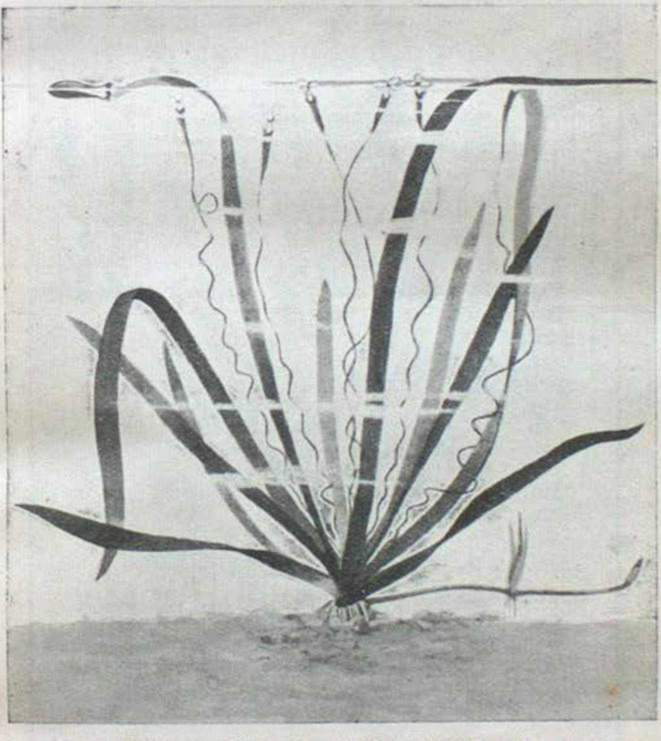
One of the most interesting phases of an aquarium is the reproduction of specimens of both the animal and vegetable world. This can only be accomplished by the perfect health of your little world in a bottle; and this again can only be brought about by judiciously stocking that little world with members of the two organic kingdoms. Specimens of the mineral kingdom may be added, but they take no part as health-giving agents. They are useful to give an ornate effect and they are valuable as a cover behind which your animals can lurk for protection.



Vallisneria spiralis, Male Plant (staminiferous).

If your pets include amphibians such as newts, or fresh-water tortoises, frogs, &c., it is imperative that a rockery of some kind be fitted up. These aquatic animals are fond of resting. Their health depends on these open-air baths. It is very interesting to see them resting among the stones, crawling over them and looking out through the openings.

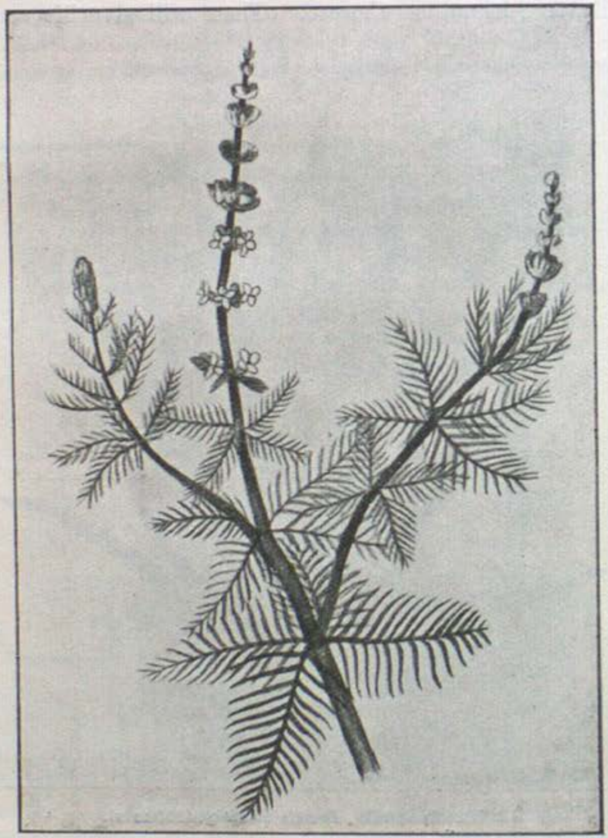
The rivers, creeks, and waterholes in this country are rich in aquatic plants. Many of them are very ornamental and picturesque when seen growing in their native element. The fine silk-like foliage of many, the thread-like stems of others, the grass-like foliage with the spiral flower stalks of *Vallisneria spiralis*, entwining one with the other freely growing in a glass vessel, make a unique ornament for a drawing-room window, especially if a few small fishes, fresh-water shrimp, pond snails, &c., be added thereto. These will give life and motion.



**Vallisneria spiralis, Female Plant (pistilliferous).**

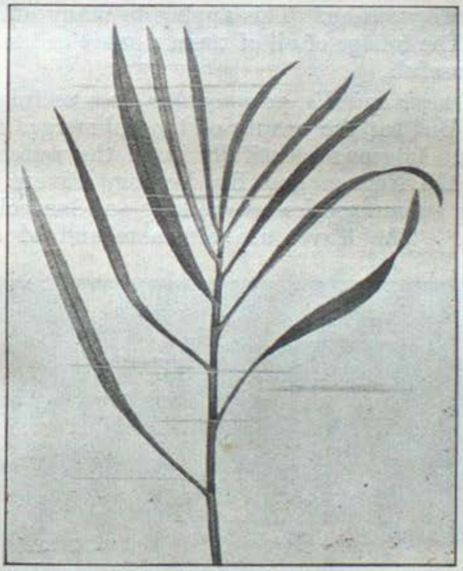
The most valuable of all plants for oxygenating water is *vallisneria*. It is diœcious, *i.e.*, the male and female blooms are on separate plants. It is a grass-like plant. The blooms are phanerogamous, as seen in the illustrations. The bloom bearing the pistil is carried to the surface of the water on the spiral stems; the pollen-bearing stamens develop as seen in the male flower. When these are mature they float to the surface, and discharging their pollen, the fertilisation of the ovules takes place. The broad-leaved *vallisneria* abounds in the fresh-water dams around about Botany, and the narrow-leaved in the upper reaches of the Hawkesbury and Nepean Rivers.

The economy of nature in producing such a corkscrew stem can easily be understood when we remember the rise and fall of stagnant waters. As an oxygenator it is invaluable for aquaria purposes. If "the blood thereof be the life" of an animal, then the life of the blood is the oxygen, and the want of it produces death. When we remember that the health and strength of the animal life in Europe is largely sustained by the wafting of the oxygen liberated from arboreal and



Spiked Water Milfoil (Myriophyllum spicatum).

other vegetation of North and South America, and that here in Australia we are largely indebted to our great forests of gum trees for the same health-giving gas, we learn how essential it is for our little world in a glass tank to be supplied with this gas from a never-ending source, a supply liberated from healthy and vigorously growing plant-life. *Vallisneria spiralis* is far above all others for the purpose. It multiplies from seeds and also by means of runners. It is said not to be indigenous to Australia but of Italian origin. Of this I am very doubtful. Be that as it may, we have a variety here that is a native of this State and far superior to the Italian as an oxygenator. Its grass-like leaves are not one-third the width. I have withdrawn them from a small aquarium, three feet six inches in length, the surface of the water not being more than a foot square.

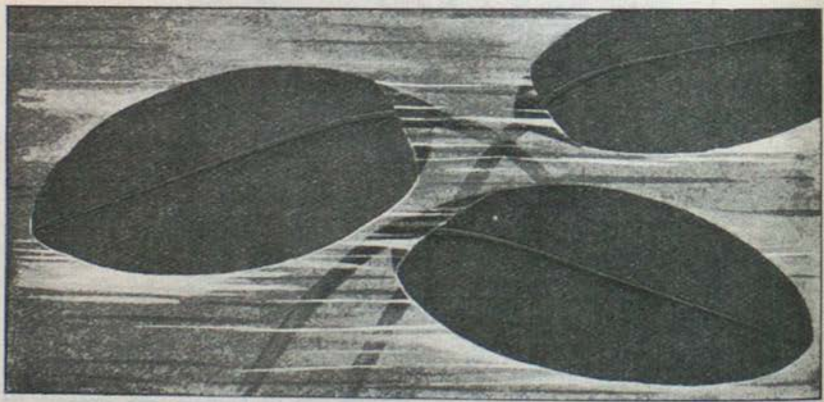


**Potamogelton natans (submerged foliage).**

The fundamental law of all terrestrial life, including aquatic life, is the reproduction of its species, and another law closely allied thereto is the search for food. On these two laws hang success or failure. In the culture of all things the primary thought should be health. Animal and vegetable life within aquaria is attractive if the specimens are kept in perfect health; if not healthy they become distasteful and wearying.

Aquatic plants, like terrestrial, are of a very diversiform character. It is this dissimilarity which creates the unique beauty of aquatic gardening. The silky foliage of the milfoils that abound more or less in all our fresh-water creeks, &c., should be in all aquaria. If not overcrowded they give a very graceful effect to the animals within. The moving fish keep the foliage in constant motion, hence their attraction. The spiked milfoil is a very great favourite with fresh-water aquarists. It has many representatives in the fresh water along our coasts. The Australian ones are more dense in their foliage than the English here represented. The leaves are longer and more graceful and ornate. When it is once established it will soon crowd out other plants and require weeding. This applies to many other of our native water plants. The foliage of all of them is more or less submerged and therefore very useful.

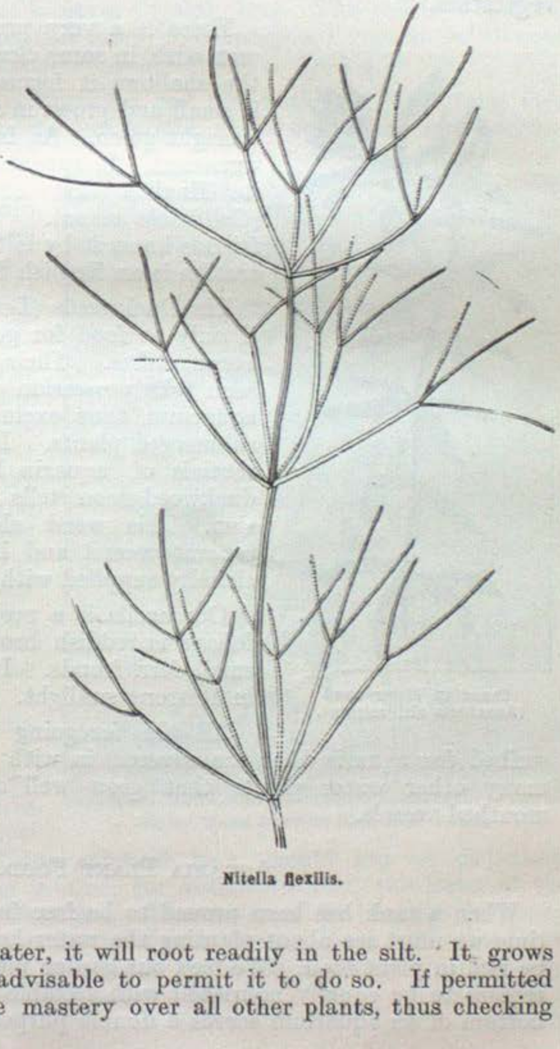
Next to *Vallisneria spiralis*, *potamogeiton*, as a useful plant, must take second place. But for the beauty of the submerged foliage all others must bow to it. It grows plentifully in all the waterholes and along the margin of the Nepean and Hawkesbury Rivers. It grows well in aquaria. Its submerged leaves are long and lanceolated, carried on a slender stem. The leaves are alternate and of a bright glossy green. The aerial foliage is ovate, a dark brownish green, very much larger than that submerged. The blooms rise about two inches above the surface of the water. The corolla is formed of three delicate white petals, beautifully crimped and star-like. The essential organs are yellow. There is a reddish cup in the centre of the flower. Thus it forms one of the most useful and at the same time one of the



**Potamogeiton natans (water-film foliage).**

most ornate of our native aquaria plants. The submerged leaves are most persistently aerating the water. The large floating leaves form a cover under which the fish are very fond of hiding for shelter from observation. These leaves lie flat on the surface of the water, like water lilies (*nymphæa*).

Our clear fresh-water creeks are rich in the growth of *Chara* and *Nitella*. The former has a simple, and the latter a compound stem. The latter is also of a finer texture. It is well adapted for aquatic cultivation. It is a plant suited to fill a vacancy for those who wish to keep their fish on the shaded side of the house, or the darker parts of a room where daylight is somewhat secluded. A few little plants intermixed with other water foliage have a good effect in checking the growth of the silk-weed and other confervas. *Nitella* has a love for clear water, and its mission among water plants appears to be to clear the element in which it grows. It has a decided objection to turbid water. If a small branch be attached to a shell or stone and dropped to the bottom of the water, it will root readily in the silt. It grows floating, but it is not advisable to permit it to do so. If permitted it will soon obtain the mastery over all other plants, thus checking their growth.



**Nitella flexilis.**

*Anacharis* (Canadian water-weed) is another plant that does not court too much sunlight. In and around Sydney all aquaria keepers have it. It is a fine harbour for insect-life, and some of the confervas are sure to be found growing on its foliage and stems. These growths supply food for the younger fishes, both herbivorous and carnivorous. *Anacharis*, like the *Chara* and *Nitella*, willsoon overcrowd other vegetation.

There is a very pretty little native plant met with in some clear stagnant waters. In the shallows it forms clusters. The foliage is small and grows in star form, in colour it is a bright green. As far as I know it is yet unnamed. In appearance it is very similar to its English first cousin, Vernal Starwort (*Callitriche verna*). The name most of my friends know it by is "Starata." The illustration is an English Starwort.

**Canadian Water-weed (Anacharis alsinastrum).**

The Duckweeds (*Lemna minor*) are valuable if only as food for goldfish and other herbivorous fishes. Their worst fault is that they soon take possession of the whole film of an aquarium, thus excluding the light from all submerged plants. Light is one of the essentials of aquaria health, and too much duckweed soon tells on the other vegetation. This weed should be grown in a separate vessel and herbivorous fishes occasionally supplied with it for food purposes.

Our azolla is a pretty floating weed. The foliage is reddish brown and like clusters of small fern fronds. It requires to be grown in a strong sunlight.

All the foregoing plants have been described for aquaria that are covered in with glass tops. There are many other water plants that grow well and look well in open-mouthed vessels.

## AQUARIA PLANT FOOD.

When a tank has been proved to be free from leakage, then is the time we must see about planting the water herbage. The soil should be rich in plant food. We feed our garden plants, and aquaria plants require to be equally nourished with suitable foods. The soil at the bottom of an aquarium serves a double purpose. It is an anchorage, and therefore it must be of a sufficient depth for the plants to get well rooted; it must also be the store room from which they draw their food supply.

The richest of garden soil is always unsuitable because it contains clayey matter. The fish when fossicking for nematoid worms, &c., in the débris are always disturbing it and the clayey matter is held in solution and the water is never crystal clear. The soil in which the plants are to be established must be decomposed organic substances. Then no matter how the débris is disturbed, it quickly settles.

The compost I use is fine shell grit (the little salt it contains does no injury) and decomposed leaf mould, about one of the latter to two of the former, well mixed together. When the plants are well rooted therein and growing freely, and not till then, should animal life be placed in the aquarium. The soil of your aquarium will never require renewing. The decomposing matter from the animal and plant life will produce sufficient humus to sustain all the herbage in a vigorous and healthy condition. It will not be many months before you will have to weed out rather than add to. There must be a sufficient quantity of the compost to form a good bed in which the various plants can be well fixed. In the larger aquaria the plants may be grown in flower pots or shallow earthenware pans. These compost beds should not be disturbed. They are the breeding grounds for aquatic worms, the larvæ of the various caddis flies, rotifers, &c. These all form the food for the young carnivorous fishes during the first year of their lives. The confervæ growing on the stems of plants and the sides of the tank supply food for herbivorous fishes during babyhood.

Vernal Water Starwort (Callitriche verna).

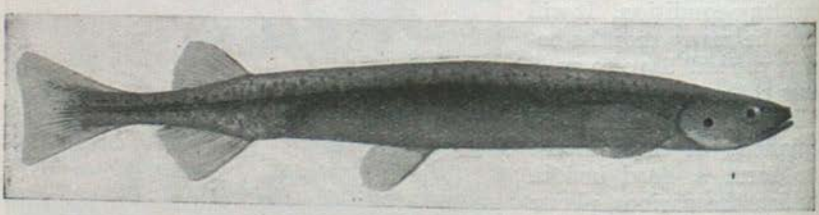
# Chapter III.

## INDIGENOUS FISHES.

*Galaxias coxii*—*G. findlayi*—*G. attenuatus*—Purple-striped Gudgeon (*Krefftius adspersus*), breeding habits of—Blue-eye (*Pseudomugil signifer*)—Gale's Carp-gudgeon (*Carassiops galii*).

*Galaxias coxii, G. findlayi, G. attenuatus.*—These eel-like gudgeons, usually termed minnows, give vivacity to our aquaria. They are full of energy, frolics and animation. When full grown they are from 6 inches to 7 inches long; they are gregarious, ravenous feeders, and soon become acquainted with those who feed them. They are long lived. They are, in nature, carnivorous, but under confinement, when flesh food is denied them they become omnivorous and will take readily to the artificial food supplied to herbivorous fishes. Nevertheless they do not thrive thereon; they soon lose their sheen and briskness.

There are three recognised varieties of these minnows known to aquaria keepers. The mountain minnow, *G. coxii*, locally known as mountain trout. They are not of the trout family. The spineless pectoral fin characteristic of the Salmonidæ is wanting. It is a shorter and somewhat deeper fish and perhaps a little brighter in its colour markings than the Sydney minnow.



**Sydney Minnow (Galaxias attenuatus).**

The illustration of the *G. attenuatus* is, as its name indicates, the most eel-like of the three. The fish are generally known either as the Sydney minnow or as long tom. They are very swift in their movements, are slate colour along the back, a dark shade along the lateral line, thence paling off to white towards the abdomen. Their fins are small in comparison to their body, and the one dorsal fin is placed only a little in advance of the caudal. Although the colour of the fish is a slatish grey, they are evenly mottled with darker blotches.

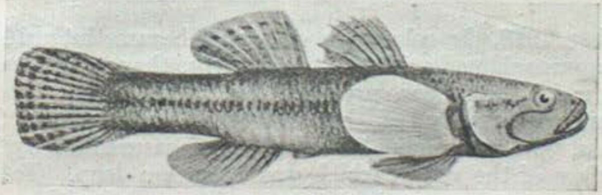
A small fly hook from which the barb has been removed, if baited with a small bit of an earthworm, will attract them readily, and if, when hooked, the hook be carefully removed, these lively little fellows are none the worse for aquaria purposes. The bait should only be sunk two or three inches under the surface of the water. The position of the eye indicates that they are surface feeders.

The Kosciusko minnow, *Galaxias findlayi*, is the brightest marked of any of the three varieties herein named. Its form is very like that of the *G. coxii*. During the winter months it is similarly coloured to its Sydney representative, but as spring advances all its fins gradually become a deep orange. Indeed during the period the females are depositing their ova they become almost a unicolour red. Such colouring is very transitory and they soon again become of slaty shades.

Accustomed to inhabit the rapidly flowing mountain torrents they are not well suited for aquaria purposes.

## GUDGEON.

The gudgeon family is a large one and contains many dissimilar fishes. *Coxii* and *Grandiceps* are only worth keeping as varieties; they are sluggish, dull coloured, and when they feed they are too fond of stirring around the roots of plants, loosening them, and always more or less keeping the water turbid. Their bodies are cylindrical, and they are generally known by the name of the big-headed gudgeon. The eyes are situated on the top of the head, or nearly so, and their general contour is by no means inviting. The head is somewhat repulsive.

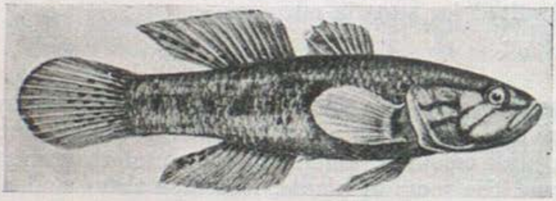


**Mountain Gudgeon (Krefftius coxii).**

## PURPLE-STRIPED GUDGEON.

The purple-striped gudgeon, *Krefftius adspersus*, although it has a general likeness and is first cousin to the big-headed gudgeon, is far more lively, spending its time largely among the weeds. The purple stripes from which their name is taken are four in number, and situated on the gill covers; the whole body is irregularly marked or somewhat tesselated with blue and chocolate colours. But interest is not centred in the fish so much as in its habits for observation purposes as specimens well worth a foremost place in any aquarium. During the breeding season their habits are fascinating to any student of nature, and will admit of any amount of time being spent in the keenest of observation.

The purple-striped gudgeons in my aquarium are about five inches in length. They have become the parents of between one thousand and two thousand children during the breeding season of 1913–1914. They first bred in 1912, and were then three years old. There was but one spawning in that year, and as a result of it I have sixteen yearlings from one and a half to two inches in length; these have all the colour markings of the adult fish. The males are somewhat lighter in colour than the females.



Purple-striped Gudgeon (Krefftius adspersus).

In October, 1913, the coloration of a pair became intensified, which indicated approaching fertility. Accordingly, they were placed in an aquarium which had been prepared for them during the previous autumn, and judiciously fed, but otherwise undisturbed. The tank was of glass, with perpendicular sides, and measured 13 by 14 inches on the surface of the water, which was 13 inches deep. To make the conditions as natural as possible it was well supplied with water-weeds and pond snails, and the anchorage for the plants was composed of shell-grit, sand and humus, no clayey matter being introduced.

Early in the breeding season (15th November) the female deposited her first batch of eggs on the glass side of the aquarium, and others ag ainon the 18th and 27th December. In the following month (January, 1914) she spawned on the 7th, 17th and 30th, and now in March she has her tenth lot of eggs. Since last October the male has been tending the various batches of eggs for ninety days.

The following observations are based on one spawning only, that of February 17th. The details were obtained twice each day, at 9 a.m.

and 9 p.m., with occasional intermediate visits. The evening visits were the most instructive, being made by the light of two or three candles, placed on the side of the aquarium opposite that on which the eggs were deposited; this clearly illuminated them, as well as the movements of the parent fishes.

On the 15th and 16th the male made preparations for the deposition of the ova by removing all confervoid growths and all foreign matter from the selected site. These he carefully cleared away with his mouth. Meanwhile the female lurked in the weeds on the far side of the aquarium. At 9 a.m. on the 16th she visited and inspected the site. Approving of it, she placed herself in a horizontal position by it, her abdomen lying at an angle of about 45 degrees, so the genital papilla had free play to eject the ova on the glass walls. Her position also gave me a clear view of her every movement. When she had settled herself the male drew near and took up a position about one inch above her. His head pointed in an opposite direction to that of hers, and his abdomen lay at right angles to the prepared site; his genital papilla was immediately above that of the female.

On the morning of February 17th the first ovum was emitted, and immediately afterwards two others followed. These were conjoined by a fine hair-like thread, and were closely followed by a string of eight. She continued to eject strings of eggs until a circular patch of about 2 by 2 inches was covered. All the chains of eggs were placed horizontally, no one crossing another. There were about twenty eggs to the lineal inch. Each egg had a gelatinous base by means of which it adhered to the glass. As the ova were being deposited the male hovered over the female, it being evident from the movements of his genital papilla that the spermatic fluid was being ejected, and fertilization taking place.

The spawning being completed, the male at once placed himself perpendicularly above the ova, frequently changing his position, his head being sometimes up, at other times down. He remained over the eggs for nine days, the period of incubation, and I suppose he obtained his food at night, as he was never feeding at the time of my visits. In thirty-six hours the gelatinous base of each egg had become elongated into a peduncle, the eggs themselves being also larger, and provided with a globule of air on the yolks. On the third day he commenced to fan them continually by oscillating his pectoral and caudal fins. These actions kept the ova in a constant swirl, and were continued until the fry emerged and took shelter in the weeds.

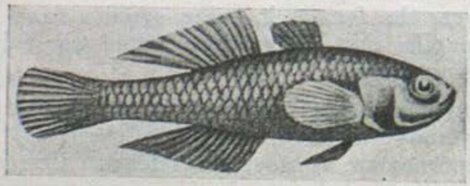
On the morning of the 20th I noticed the first signs of eyeing. At 9 p.m. they were distinctly visible. On the 25th at 9 a.m. the fry were emerging from the eggs, nine days after the ova had been deposited.

For a while they hung head downwards from the empty egg capsules by means of their tails, which were bent like the curve of a fish-hook. The motions of respiration and a tremulous movement of the pectoral fins were the first indications of life. At 8 p.m. the following day they had all dispersed among the weeds, where they were further guarded by the male for another twenty-four hours.

The temperature of the water at this time was about 80 degrees. Indeed the variation in the heat of the water only differed between three and four degrees during the whole time of incubation. There were no sterile eggs in the first few nests; the first infertile one being noticed in the fourth spawning. The eighth nest contained 13, and the number continued to increase as the season advanced. They were among the last eggs of the batch deposited. In colour they were of an opaque white. Thus they were easily distinguished from the gelatinous fertile ova.

### GALE'S CARP-GUDGEON (*Carassiops galii*).

Gale's Carp-Gudgeon is a very handsome specimen, and a great addition to an aquarium when contrasted with its congeners. It is very shy when first captured, and runs to cover as soon as any movement is made near home. It is a small fish, being only about 2½ inches in length, and symmetrically deep. In colour it is grey or slate colour, paling to a white on the abdomen; the dorsal fins are two in number; the pectoral and caudal fins are lemon, and as the breeding season draws near become almost orange.



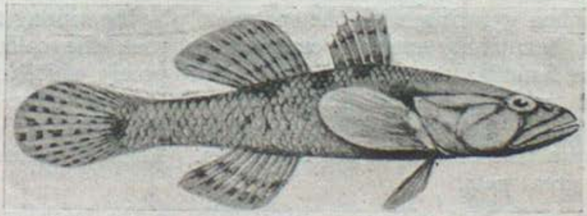
**Gale's Carp-gudgeon (Carassiops galii).**

As a Nature study, their breeding habits make them very attractive. Lovers of fish-life have few such opportunities of obtaining valuable information direct from Dame Nature's open volumes, on the subject of the perpetuation of species. The male selects the site for the deposition of the ova always on the shady side of the aquarium, and fully in the view of the observer. When the site is chosen, both the milter and spawner evince a deal of anxiety in regard to its suitability for the cradle and the reception of the anticipated ova. All algæ, confervæ, and deleterious matter are carefully removed. While the site is in preparation the spawner is watching every movement as the work progresses, and coyly approaches the bridegroom elect, tremulously hovering to and fro until she settles herself, and receives further attentions from the milter. They are monogamous. Both parents are very watchful of the slightest interference from wandering outsiders that venture too near the cherished home.

There is method in the deposition of the ova, each egg being dropped singly and equidistant. The ova are placed on a perpendicular surface, the spawner reclining at a slight angle, and lying horizontally. The milter takes his place on the same site. He too lies horizontally, but in an opposite direction to that of the spawner. With slightly quivering fins he places himself upon the prepared site, somewhat above her. In about six hours the first act of nidification is completed. In another three days the little prisoners' eyes can be seen within the ova. The eggs are attached to the site by a gelatinous stem. After eyeing, the embryo fry matures rapidly; the baby inmate begins to oscillate; this vibration soon frees it from captivity. As the fry emerge from the ova they can be seen hanging on the capsules of the eggs, and soon they lead an independent life among the submerged foliage of the aquarium. On the site where they were cradled there is nothing to be seen but the empty capsules of the eggs.

### FLAT-HEADED GUDGEON (*Philypnodon grandiceps*).

This fish is rather a grotesque looking specimen. It is one of our small fishes to be met with along fresh-water creeks and waterholes on the coast. It can always be found hanging about the weeds in the localities named. It has little or nothing to recommend it beyond being an additional variety in a collection for aquaria purposes

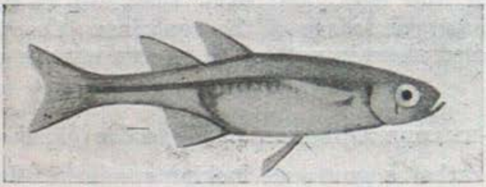


**Flat-headed gudgeon (Philypnodon grandiceps).**

Its colour is brown mottled with darker shading. The dorsal fins have chocolate brown crescent marks; these with its very prominent eyes are about the only marks of distinction they possess. They remain stationary, watching for their prey for hours together.

## PSEUDOMUGIL SIGNIFER.

One of the most beautiful indigenous aquaria fish we have in New South Wales, both in colour and markings, and at the same time the most shapely, is the little Blue-eye (*Pseudomugil signifer*). The adults never exceed 2 inches in length, and its depth is symmetrical to its length. Among imported aquaria fish specimens, the Paradise fish and the Fighting fish (*Betta pugnax*) are its only rivals. In spring time, the breeding season, the sexes are very readily distinguished; the male, as is always the case in the fish-world, attires himself in his wedding garb, his fins become more developed and expansive. His whole body assumes a maize tint, his fins the colour of old gold edged with black, having a very narrow margin mottled with gold and white. The eyes of the male form a very striking contrast with the general markings of the body, being azure or sky blue and bright and lively, the whole contour giving the fish the appearance of aquatic butterflies rather than that of fish. The males are far more resplendent in the breeding season than are the females.



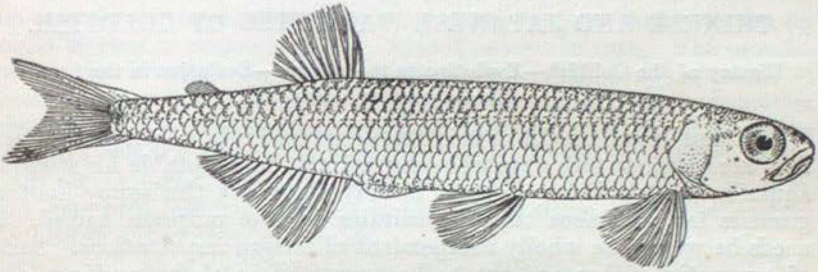
Blue-eye (Pseudomugil signifer).

Both the males and females are very coquettish. In love-making they are communistic, and being gregarious both in winter and summer a number of males always accompany the female. They are active and vivacious when gyrating with the spawners playing among the weeds. There is a beautifully marked contrast between the colours of the sexes. The females are a pale grey shading to pearly white underneath, with black markings on the dorsal fins. In winter there is a great similarity in the colour of the sexes, but the males can always be detected by a black mark on the dorsal fin. Their friendliness makes them very great pets.

They are to be met with very plentifully in the fresh and brackish waters in the creeks along the coast-line of New South Wales, and can readily be taken by means of a small hand-net.

Their natural food is rotifers, and the various varieties of animalculæ. They are very fond of mosquito larvæ. In confinement they do well on coffee biscuit, occasionally varied with a little flesh food or gentles.

When caught they require careful handling; they are very timid, and many die with fright. When collecting put some water weeds in the can. Don't be greedy and overcrowd the can, as with the greatest of care 50 per cent. will collapse in transit.



**Australian Smelt (Retropinna retropinna).**

The Australian Smelt (*Retropinna retropinna*) is the only known indigenous representative of the great family of the Salmonidæ, to be met with in either the fresh or salt waters of Australia. Unlike its brethren, the trout and salmon, which are chiefly confined to the northern hemisphere, it is not migratory; it is purely a fresh-water fish. It is small, seldom exceeding 3 inches in length, and, therefore, of little or no commercial value, but as an additional inmate to aquaria it is well worth the trouble of keeping. In colour, its back is a deep, glossy steel grey, slightly maculated, shading to white on the abdomen. The fish, in its native habitat, is always to be found swimming near the surface of the water, and is therefore a lover of pure oxygen. This natural trait militates against its becoming a general inhabitant of our aquaria; it takes some trouble to domesticate it to the confinement of small tanks of water.

The Salmonidæ are easily distinguishable from all other species of fish. There is a small fin situated about midway between the caudal and dorsal fins. This fin, which is rayless, is usually termed the "adipose fin," and has not the power of expansion and contraction as is the case with the other fins of the fish.

It is very much smaller than the smelt of the English rivers, where it was known to the writer in his schoolboy days as the "cucumber fish" on account of the odour it emitted when just captured.

# Chapter IV.

## CHINESE AND JAPANESE VARIETIES OF GOLDFISH.

History of the Goldfish—Evolution in the colours—Evolution in the forms—Their breeding habits.

The fresh-water creeks of this State, especially those along the coastline, are teeming with vegetable and animal life adaptable for stocking aquaria. Cook's River and the Botany Dams are the happy hunting grounds for specimens that are suitable for the purposes named. If needs be we can be wholly independent of foreign importations. Some of our native fishes are not to be surpassed in their markings and coloration, and also in the beauty of their forms. Others, although of sombre hue, are most graceful in their symmetrical movements. During the seasons of love making they are full of vivacity, and their dusky tints shine with a metallic lustre that make them extremely attractive.

The Goldfish (*Carassius auratus*), considering that it has been bred, domesticated, and kept in small glass aquaria for the last 700 years, can hardly be looked upon as a foreigner. It was one of the fish earliest introduced to these States. During this period it has sported into the most grotesque forms, gorgeous colours and maculated tints. It has become a pet with those of high degree and of lowly birth.

The primitive type, of a metallic bronzy colour, is to be found in all rivers, creeks and waterholes in Australia, and the same can be said of Europe. In many of these waters some of the fish taken have red or golden tints and other peculiarities showing that the original ones were liberated from captivity. Seldom is a bicoloured fish captured. Yet under domestication colours and forms have undergone marvellous and incredible preternatural changes. Not only have these fish undergone an evolution in colour and form, but in some their very movements have changed. There is a variety that can loop the loop as cleverly as an airman. Who has not seen the tumbler pigeon turning somersaults in the air? Some of these fish can do the same thing. In their gambols their acrobatic feats are astonishing. But they must have room wherein to play.

There is nothing surprisingly beautiful or grotesque in the primitive type. The only thing that caused their being taken as pets was their contentment under captivity. The Chinese and Japanese are credited with having domesticated them. History records their introduction into Europe as far back as 1611 A.D. To this day the Chinese are devoted breeders of them, their chief hobby being the production of those of the most prismatic colours. The Japs have taken a hand in producing extraordinary forms.

It is a mistake to think the golden carp (*Carassius auratus*) is a descendant from the common carp (*Cyprinus carpio*). If such were the case there would occur cases of atavism and the barbel on the lip would be sure to re-assert itself. Such is never the case. The original type is the Prussian carp (*Carassius gibelio*). The original colour of these fish is a lustrous metallic bronze. Indeed it does not matter what variety of goldfish you breed, in infancy they are all of the primitive colour. The adult colour is assumed very gradually. Some when six or eight weeks old will show their colour. Some of mine that were bred last year are still in the bronze stage. Some will retain the bronze colour throughout life.

There has been an evolution in every detail of this fish. All the fins are greatly elongated, the anal fins are often duplicated, and in some the dorsal is wholly absent. The caudal and other fins are sometimes extraordinary monstrosities, almost surpassing description.

The common carp, including the golden-tinted ones, are very plentiful in Cook's River and waterholes adjacent thereto. All the carp taken from these are lacking in resplendent colours. Those having abnormal fins and other preternatural development are never met with. They are all cases of atavism (throwbacks).

When bred under artificial conditions and if kept perfectly healthy there is no difficulty. From the same brood, from the same parentage, you can hardly select two that in form, colour or markings are alike. Their long gauzy and feathery fins appear never to be the same, never in two cases alike.

The breeders of these beautiful fishes have not confined themselves to evolving new forms in bodily shape, producing abnormal eyes and development of fins, but in colour these fish have undergone wonderful changes. When once you can get a flower to sport in form or colour there is no knowing what beautiful colour or form there may be in the future of that plant. So with these fish. The Chinese saw there was every chance of obtaining new and varied tints and shades. So with the Japs in extravagant forms to be wrought out.

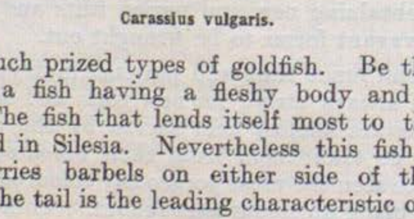
The Chinese spend much time and patience in developing the colours of these fish and always strive for new tints and shades. The most beautiful varieties are almost held sacred by the mandarins, and it is not permitted to take them from their breeding-place. With the mandarins are to be seen the most gorgeously coloured. There are some of a deep velvety black unicolour throughout. Some have their sides beautifully mottled. Blue, rose, and black are not uncommon mixtures, the shades in each case paling to a silvery metallic white underneath. Perhaps one of the most beautiful is that having the upper portion of the body evenly variegated with a bright red and black, each scale being margined with gold. There is another type having a blue body and red fins.

Japan has given us those queer-looking telescope fish, some with normal tails, others with tails fan-shaped or fringed. The lovely feather-like fins as seen in the fish bred by the author belong to the Japanese fish. One of the most curiously shaped, at the same time of curious habits, is the tumbler. The body is crescent shaped. These varieties are constantly interbred and fresh forms and colours produced.

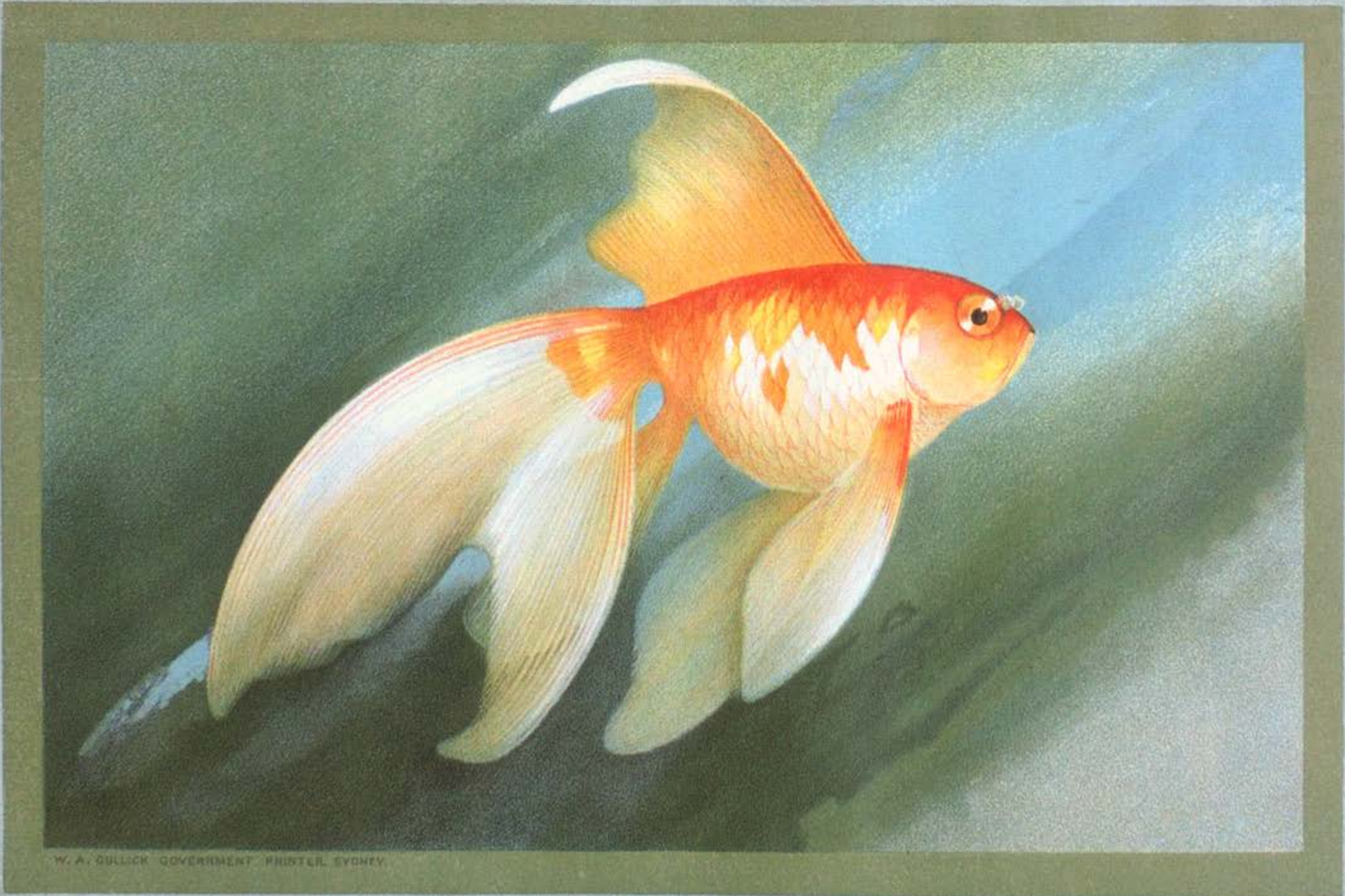
### TYPES IN THE EVOLUTION OF THE CRUCIAN CARP (*Carassius vulgaris*).

The feather-finned carp pictured on the opposite page was bred by the author. The caudal is superbly fringed and feathery, in fact all its fins are more like feathery plumes than appendages to a fish. The dorsal curves beautifully, and when erect exceeds the length or depth of the body that carries it. The anal fins are wanting. One of the most beautiful specimens to be met with. It will be noted that the olfactory organs are greatly developed, far more so than in any of the other specimens.

The primitive type from which all our grotesque and vari-coloured goldfish have been evolved is the golden carp (*Carassius auratus*). Yet it is sometimes doubted which of the many forms and shades of colour among the varieties of carp to be met with in Europe, can claim the honour of being the forerunner of our much prized types of goldfish. Be that as it may, it must have been a fish having a fleshy body and a deeply forked swallow tail. The fish that lends itself most to these peculiarities is the carp found in Silesia. Nevertheless this fish is almost scaleless and it carries barbels on either side of the mouth. The development of the tail is the leading characteristic of the present-day



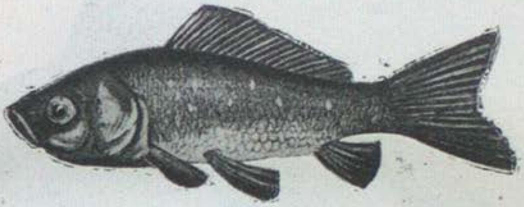
**Carassius vulgaris.**



FEATHER FINNED CARP

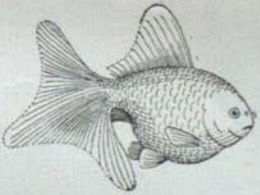
W. A. GULLICK GOVERNMENT PRINTER, SYDNEY.

goldfish. We know the aquaria goldfish has developed in every member of its body, yet the barbels never intrude or re-assert themselves. Another thing, European carp show little or no fork whatever in a state of nature.



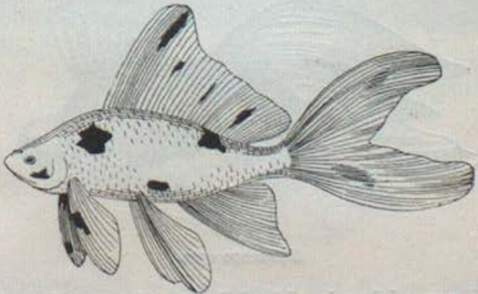
The Common Goldfish.

In the common goldfish it will be noted that the form and colour of the body only have undergone changes. All the fins are normal.



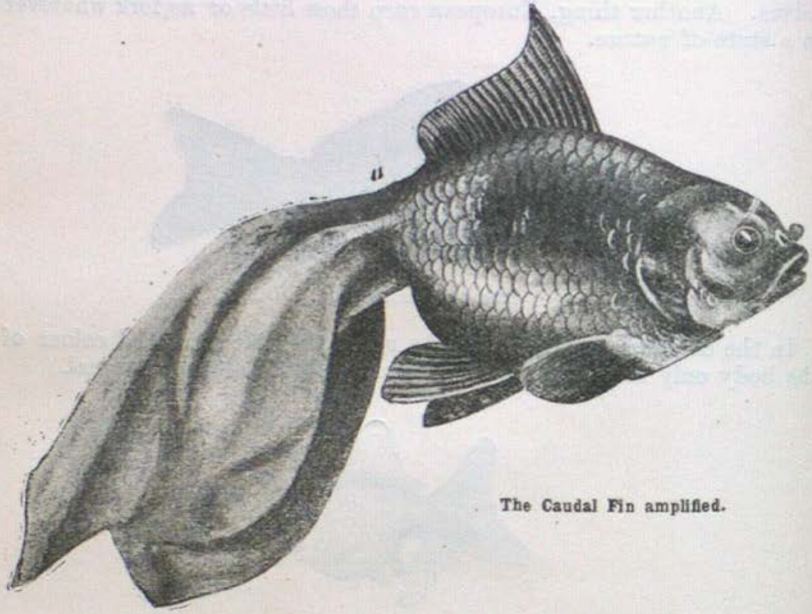
This fish has a vertical caudal.

This specimen has a deeper body; the pectoral, the abdominal and the anal fins are normal, but the dorsal is enlarged and the caudal triangular and vertical.



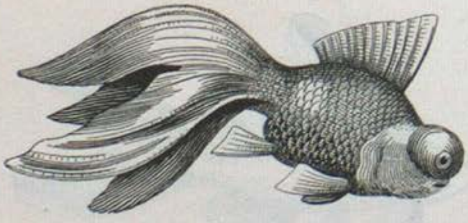
The Comet.

The whole fish, including the fins, is much elongated; the body compressed, and the caudal much forked. This fish is named the Comet.



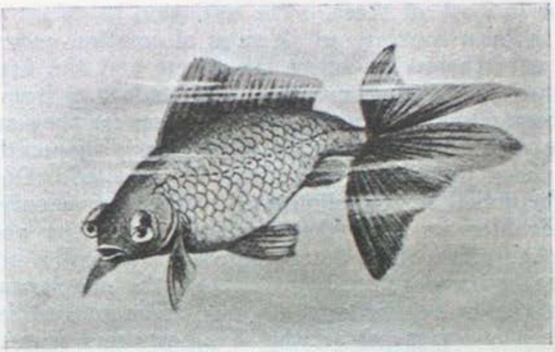
The Caudal Fin amplified.

Fins normal, but the caudal and the rotundity of the body greatly developed, when compared with its prototype, is seen to be greatly amplified.

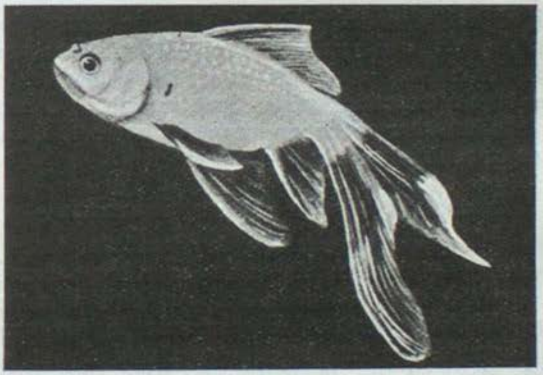


Telescope eyes.

The organs of propulsion in this fish are of excessive size. The only fins normal are the abdominal and pectoral. This and the following belong to the variety known as telescopic. The eyes are greatly distended, the caudal is beautifully fringed, and the dorsal is of abnormal growth.



Another telescopic type, the caudal fin fanned and split. The first change in the caudal was that of becoming fan-shaped.



The fish normal excepting the caudal and fins. This is one of the earliest types of the tail developing fringe-like properties.

The only abnormality is the rotundity of its body. Its beauty consists in its colours.

There is no knowing, when a variation is once produced in any member of the organic kingdom, the divergencies and in what direction such divergencies may tend. It may be in colour, it may be in form, or it may be in both of these. The variation in colour may be distasteful, or in form contrary to all rules of creation according to our standpoint, nevertheless we select the fittest and the fittest survive. In the illustrations the abnormalities, or irregularities from the normal type, have been selected from time to time because they are agreeable and coincide with our idea of what should be. Frequently abnormal forms have been distasteful and therefore rejected. Once in these evolutions the dorsal fin was eliminated altogether, or only a few rays near the shoulder or near the caudal or over the abdominal fin remained. Again two short dorsals appear as though a bite had been taken out, or two undeveloped fins appear, the one forward and the other nearer the tail. The anal fin has undergone some wonderful changes. In the comet fish all the fins have undergone elongation. The writer has many specimens in which the anal is duplicated. In another specimen there is a double caudal placed horizontally, and the writer has also produced a fish having a vertical twin caudal fin It is now in the Sydney Museum

In a brood of last season's goldfish there are many shades of red maculated with pearly white; in another all the fins are abnormal, with two caudal fins and a double anal; the whole body is a pearly white, giving the appearance of a little seraph. Others have two upright fins. In another specimen there is a vertical caudal giving the appearance of a little man in a boat.

## BREEDING HABITS OF THE GOLDFISH.

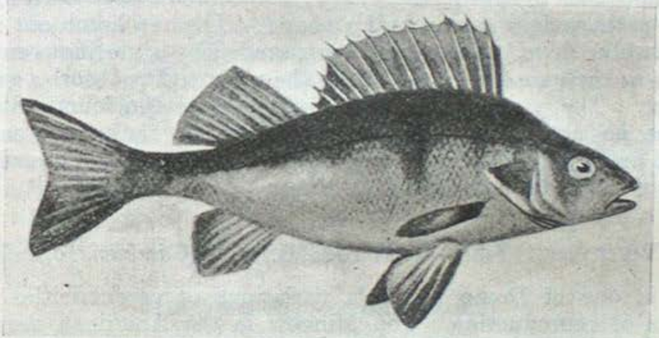
The goldfish and other carp are, in their natural state, gregarious. Many varieties of gregarious fishes, as the breeding season approaches, pair off and separate from the main body. Goldfish are not of these latter. During breeding seasons they remain in congregations, and the consummation of the marriage is communistic or promiscuous. Under domestication pairs can be selected and bred to a type. They are in no way monogamous. Where it is desired to breed to a certain type, by selection, under domestication, as it is often done among the Chinese, this can be done by selecting the desired fish.

These fish spawn among floating weeds where there is absolutely promiscuous intercourse, both the males and females intermixing indiscriminately. In their gambols through the weeds the females take the lead closely followed by a contingent of males. The spawn and sperm are ejected among these weeds. The ova are glutinous and adhere to the first body they touch. These may be collected on a sheet of glass as they precipitate. This piece of glass can be turned to the front of the aquarium and every change noted till the young emerge. It is highly interesting and instructive to watch these changes. For other information *re* goldfish, see Fish Emotions, page 63.

# Chapter V.

## INTRODUCED FISHES.

English Perch—The Top Minnow—Medaca—The Zebra Fish and their habits—The Climbing Perch.



English Perch (Perca fluviatilis).

### ENGLISH PERCH (*Perca fluviatilis*).

The English Perch is now well acclimatised in Australian freshwater rivers and creeks. They adapt themselves well to waterholes provided there is plenty of herbage growing therein, and therefore they are well suited for aquaria purposes. They readily breed in confinement. Being gregarious when young many can be kept together. They should be kept in a cool situation, especially in summer seasons. They easily become domesticated and soon recognise the hand that feeds them, and willingly take a wriggling earthworm from the fingers. Nevertheless they are very timid, and when confined in glass vessels injure themselves by dashing from side to side.

In form the fish is rather peculiar; its shoulders rise suddenly, giving the appearance of a hump, or hunch-back deformity, which falls away rapidly towards the caudal fin. There are two dorsal fins. The first has well developed sharply-pointed spines. When the fish puts on its fighting armour these fins stand erect, giving it a fierce, pugnacious look. The second dorsal has only soft rays. The fish is very prettily marked, the back is a bronzy green, shading down to a golden maize, paling to white in the abdomen. The sides are ornamented with six wide greenish vertical bars; the lateral line taking the curve of the high shoulders. The fins are scarlet, excepting the second dorsal, in which the scarlet is tinged with green. As with most other fish, the colouring is very radiant in the season of courtship. At all times these fish are very handsome and interesting.

Their season of love-making is in early spring. They are prolific breeders and they increase very rapidly. The eggs are deposited among the stones and weeds near the bottom of their habitat. These are laid in long strings, resembling a necklace of beads 3 feet or 4 feet long and sometimes as much as 5 feet. Like the cod, these fish carry many thousands of eggs in the ovary; 280,000 ova have been found in a small perch weighing only half a pound. The ova hatch out in from ten to twelve days. Each egg is surrounded by a glutinous envelope. As soon as the eggs are exuded from the parent they absorb a quantity of water. The young commence feeding after the fourth day. If there be no natural food in plenty within the tank, food must be supplied artificially, that is to say, the food recommended elsewhere for the fry of carnivorous fishes.

### A VIVIPAROUS FISH—THE TOP MINNOW (*Gambusia affinis*).

This is one of Dame Nature's variations or eccentricities in her methods of reproduction. Top Minnow is the American vernacular for that interesting little fish the *Gambusia affinis*. These lively little fellows abound in the marshes and lagoons of the South Atlantic, and also along the coast of North America from Delaware to Mexico; and northwards to Southern Illinois. They are quite at home either in the brackish or fresh waters of these localities.

Scientifically, these are the most interesting specimens among all my aquaria inhabitants. When full grown they do not exceed 2 inches in length, nevertheless they are well proportioned. The difference between the sexes is well defined. The male is much smaller than the female. Even in babyhood the male exhibits the distinctive peculiarities of his sex, the elongation of the ventral fins, necessary for perpetuating his viviparous species; that is to say, the rays of each ventral fin are greatly elongated. When the movements of the male are normal these fins remain quiescent, tucked in closely to the body and extend nearly to the caudal. They are used as claspers, but under sexual excitement are placed forward. extending well beyond the muzzle of the fish, thus forming one of the chief attractions to his mate. The movements of these fins during the mating season are most peculiar. The fish has the power to move them in any direction. They breed freely in small aquaria.

While the object of his attentions is gracefully moving hither and thither or playing at hide and seek among the floating herbage on the surface of the water, the male frequently changes his coloration and his every-day garb becomes intensified in brightness, the female becoming more sombre in her dress. (The normal colour of these fish is a pale maize shading to white towards the abdomen.) With his two claspers extended forward he is constantly searching among the herbage for the object of his affections.

The young come into the world alive and with their eyes open; they are born among the surface weeds, and not hatched from eggs, as is the case with nearly all other fish. They come forth four or five at a birth, and there are four or five productions of them during a season. For the first few days the parents are very solicitous over their newly-born offspring. Hitherto I have been unable to discover the period of gestation, but as coming events cast their shadows before them, it is somewhere between two and three weeks.

They are not cannibalistic as is too often stated. In early spring I had only a single pair. These were kept in a small glass jar, surface measurement 5 to 7½ inches and 8 inches in depth. This was well stocked with subaqueous plants and well supplied with pond snails. The number of fish born to that pair was 18, and so far I have seen no deaths.

### THE MEDACA (*Oryzias latipes*).

This fish is sometimes known as the Japanese Rice Fish and frequently as the Japanese Blue Eye. When kept in an aquarium with *Pseudomugil signifer* it forms a very pretty contrast. The steel blue of the one and the bright lemon shades of the other blend well together when intermixed with the green herbage. In the spring the males are beautifully maculated with small spots of a metallic lustre. The female carries her ova for some hours between her pelvic fins, and in that position they are fertilised. After carrying thus she suspends them like strings of minute beads on the foliage of the submerged plants, where they are left to take care of themselves. Pond snails and beetles prey upon them, therefore they need some care in protecting them. In three or four days the young can be seen moving among the weeds.

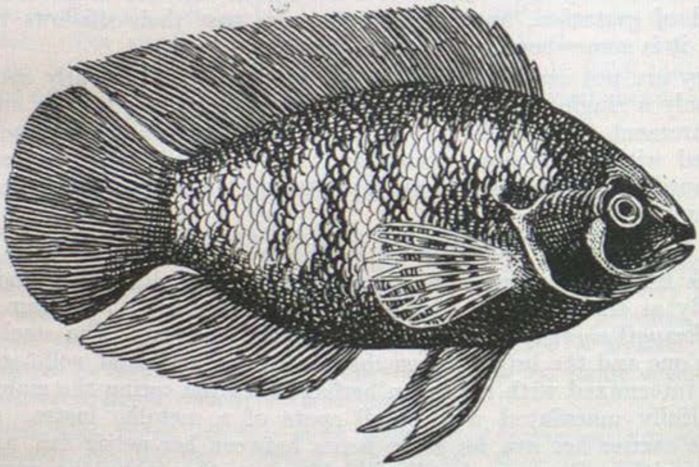
The same treatment in regard to food as the *Pseudomugil signifer* will keep them in health and strength. They are very delicate and fragile and appear ill prepared to fight the great battles of fish life.

These Rice fish are often seen exposed for sale in the bird shop windows in Queen Victoria Markets.

### ZEBRA FISH AND THEIR HABITS.

The Zebra Fish (*Heros facetus*), when full grown, attains about 5 inches in length and 2 in depth, but with its fins fully expanded its depth is about two-thirds of its length. Its body is covered with very small scales from its mouth to its caudal fin. Among ornamental fishes it is at once one of the most beautiful in colour and form, and in its parental solicitude for the welfare of its young its affection is equal to that of many terrestrial animals.

The pair I have now before me are about 4 inches in length by 2 inches in depth. The dorsal and the anal fins are single, well developed, and both extend fully two-thirds down the caudal; the pectorals, through which the markings of the body are distinctly seen, are rather large and semi-transparent; the ventral fins are well forward, pointed and stratified, and coloured similarly to the markings on the body; the caudal is very much rounded, and during the breeding season is a velvety black. The ground colour of the foreign little beauty is golden, beautifully pencilled with broad, irregular bars of black corresponding with the velvety tint of the tail fin, margined with dark purple. Their stripes reach from the abdomen well into the dorsal fin. Their eyes are a reddish yellow, more like a small flame of fire, and, when excited, flash rapidly.



**The Brazilian Zebra Fish (Heros facetus).**

Their breeding habits deserve special notice. In spring, and during their period of courtship, their beautiful prismatic colours are at their zenith. The site selected on which the eggs are to be deposited is not arbitrary; sometimes it is on the leaf of a plant, sometimes it may be on a stone, but the spot must be well hidden from view. Having chosen it, the male commences preparing it for the reception of the ova. If a leaf be chosen the cuticle is carefully removed, perhaps for the displacing of deleterious matter injurious to the developing young. This accomplished the female examines the prepared site. Slowly moving along it, she drops egg after egg. She appears to be in no hurry. During the process the male is deeply interested in her every motion, attentively watching for approaching enemies, his whole frame quivering with excitement, and his fins rapidly twitching. The eggs being placed in position, the male passes over them. A joint guard is then kept for four or five days, when the fry commence to appear. Never was a hen more excited with her first brood of chickens than this mother fish with her clutch of young, in which interest the father shares equally. All paternal emotions are strongly in evidence, and the helplessness of childhood is seen in every movement of the young for the first few days. As a clutch of chickens, they are content to follow the parents, closely nestling around them, whilst both father and mother are on the alert to ward off all danger. No matter what or how big the supposed enemy may be, the attack is instant. I have placed my hand 2 feet from the parents and young, and I knew their presence by a nip on the back of the finger. When three or four days old, the feeding begins. This duty is relegated to the male only, as far as I have seen. He picks up mouthfuls of silt lying on the bottom, jerks it through his lips, the little fellows eagerly watching and searching for any animalculæ. As they grow in strength they require firmer food. This is supplied by feeding with rotifera and mosquito larvæ. I have more than once seen the male take an earthworm, masticate it to a pulp, jerk it through his lips and the little ones greedily devour it. There is nothing cannibalistic about them. I have seen the parents make a dart among the mosquito larvæ and take one of their own young in mistake, but they at once eject it. Two or three broods can be permitted to live with their parents through the winter months. This is very economical. They are very susceptible to cold, and will only live for a few hours at a temperature below 56. My aquarium contains about 40 gallons of water, wherein are the old and young fish. In this aquarium, at one end, I always, before going to bed, place a rubber foot-warmer, containing a gallon of boiling water (212 deg.). This raises the temperature at one end to 62 degrees; at the far end it is not over 58 deg. In the mornings it is very interesting to note the baby fish closely swimming around the bottle for the extra heat.

After two or three generations they become acclimatised, and with ordinary care and the aquaria protected at nights with covering they will pull through our winter months.

The adult fish are very pugnacious, and are frequently engaged in duels. The mode of attack is interesting, and the fight is always between rival males. Approaching each other, they robe themselves in full war paint. Their eyes flash out defiance Slowly advancing, every fin quivering with excitement, the challenge to combat is at once accepted; with open mouth they commence the tussle, grasping each other with open jaws; then jaw locked in jaw, lying on the bottom, it becomes a real tug-of-war. It is not for long; the vanquished retires. The fight is frequently renewed.

I have now the third generation bred from the original pair, they require no artificial heat if kept in a room, the Sydney winter is not too severe for them.

They commence breeding at two years old, that is to say, in the third spring.

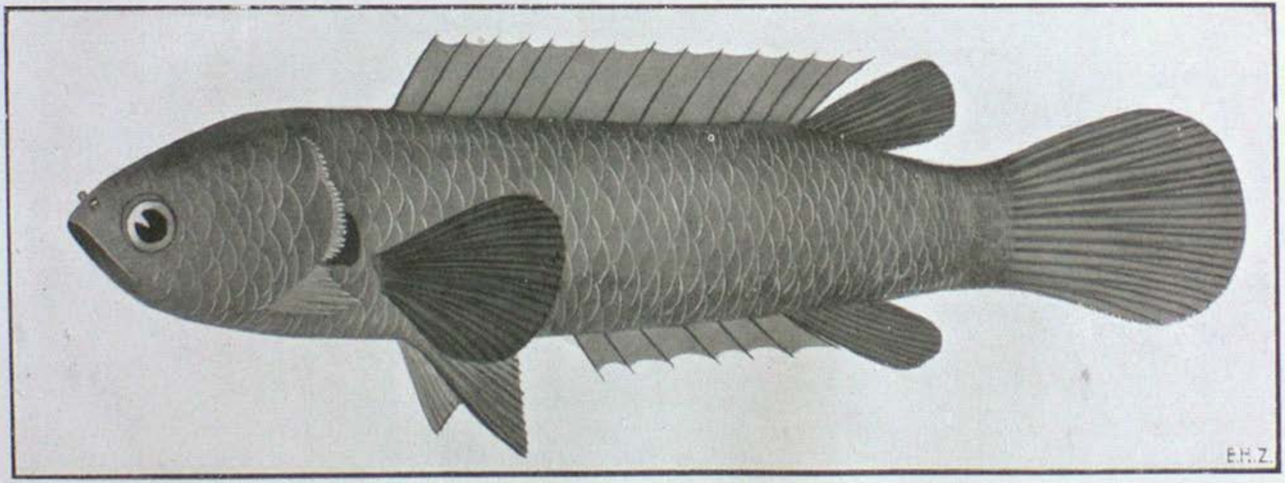
In winter months it is difficult to supply the young of these zebra fish with mosquito larvæ, and although earthworms are plentiful, I have not noticed the parents supplying this food, therefore I have recourse to an artificial food as near to nature as can be obtained. A fowl's or lamb's liver boiled hard, and dried sufficiently to be grated fine; to this is added a small portion of coffee biscuit, and also some dried prawns, pulverised, about equal in quantity to the liver. I find this an excellent food for raising most young fish.

### CLIMBING PERCH (*Anabas scandens*).

This is another of those labyrinth-gilled fishes, although not a nest builder. No fish is more tenacious of life than this perch. They will remain for five or six days out of water, but as a tree climber it is more than doubtful if they ever accomplished the feat. I have kept them, and the most amusing trait in their character is that they are great pedestrians. Taken from the fish tank and placed on the lawn they created no end of amusement as they ambled from place to place about the lawn.

I do not think the Sydney climate is congenial to them. Those I had were short lived. They died during winter. They would make a valuable addition to our aquaria if only in the study of their habits.

It is recorded of them that fishermen on the Ganges River have kept them five or six days without water, and that after a water famine lasting so long they have been found as lively and fresh as the day they were caught; nevertheless there is considerable doubt whether they have the power of tree climbing. Among cases that have been recorded, Sir Joseph Banks states that in the year 1791 he took one of these climbing perch from a moist cavity in the stem of a Palmyra palm "which grew near a lake," struggling to get higher. Was it not rather struggling to get down? There was no motive for this fish to climb; the lake of water was close by, its food was in the lake, and it does not breed in trees. No one has ever seen them climb; they have been seen only on one or two occasions in the cavities or bracts of the palm leaves, probably dropped there from the talons of some fishing hawks.



Climbing Perch (Anabas scandens).

Sketched from a living specimen in the Aquarium of Mrs. Ashton, Dulwich Hill

# Chapter VI.

## NEST-BUILDING FISHES.

Paradise Fish (*Macropodus venustus*), breeding habits—Fighting Fish (*Betta pugnax*)—Gourami—Stickleback and nest.

When the rigor of winter is passing away and terrestrial and aquatic vegetation is showing signs of a speedy revival, it is time to give attention to your little garden in the bottle. Carefully inspect your aquarium and set it in order by removing all deleterious matter. Vegetation will soon respond to the treatment. The sturdy healthy green of the plants will speak volumes for the purity of the medium in which they grow. Confervæ and algæ will make their appearance on some of the foliage. These are valuable growths where it is intended to rear young herbivorous fishes.

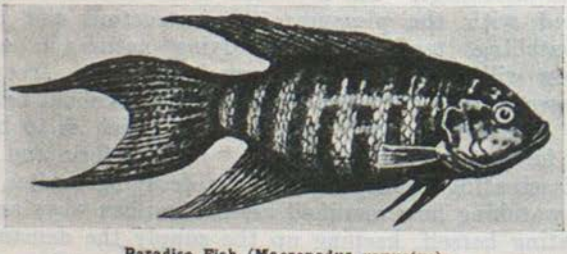
You will observe the mature fish are becoming glossy, their fins are expanding and their appetites keen—true signs of health and strength. As the spring advances, your water garden, unobserved by you, is being gradually filled with insect life and animalculæ—a grand acquisition and aid to the life and growth of young carnivorous fishes. As spring advances you will see all the labour and care you have bestowed on your aquaria during the winter months have not been in vain. Not very far ahead you will see signs of reproduction which it will be well to examine and encourage. The mysteries of an unknown world to those unacquainted with the pleasures, the instruction and the mental rest in watching, tending and studying nature in a drawing-room window will begin to make themselves known. .Peep into one of Nature's workshops, just scanning how she goes about her every-day work, how she models and fashions that which is to be, bringing shapes and forms from things that are " without form and void," and things of fascinating beauty from slimy decaying matter, delighting the eye in watching how manifold are her various ways and methods of perpetuating herself, keeping up the supply the demand requires, the recasting and the reproducing of the many members to continue the species and varieties of her vast family of fish life.

How different are her methods of perpetuating animated nature from those of the vegetable world! Yet, after all, there is an inexplicable and unexplainable sameness. Among the finny tribes, as among other animals, they marry, and are given in marriage, and the command, "Be fruitful, and multiply and replenish the earth," is consummated to an excessive degree in the fish-world.

How very few of the ova deposited by the spawner become adult fish, not because the eggs are infertile, but on account of the great number of enemies feeding upon them. The utter helplessness of the young, and their want of cunning expose them as a very easy prey to all enemies. There are exceptions. The young of some seek cover almost as soon as they are hatched; others are shepherded by the father —never, so far as I know, by the mother. Some fishes receive the eggs of the female in an abdominal pouch, others deposit them in the mouth of the male, or rather he collects them, hiding them in the bronchial cavities, and thus protects the young until they are capable of self-preservation. All baby fish collect their own food—the zebra fish is one exception.

Where is the volume that can give the details of the gyrations, the gambols, the display of gaudily-coloured fins, the ornately shaped body with its alternating colours, the changes from tint to tint, and shade to shade; the eyes sparkling and radiant more like living jewels than the eyes of fishes.

All fishes that take to confinement in an aquarium, even if they retain their health and thrive therein, are not equally interesting and profitable as nature studies. Indeed many of them can hardly be said to be sufficiently decorative to deserve a place for ornamental purposes. Too many of our indigenous fishes, although they thrive in confinement, are neither useful nor ornamental. The flat-headed gudgeon (*Philypnodon grandiceps*) is not worth capture. Its habit is to lurk among the weeds and show itself only at dusk and early dawn. Even then its movements are not graceful.



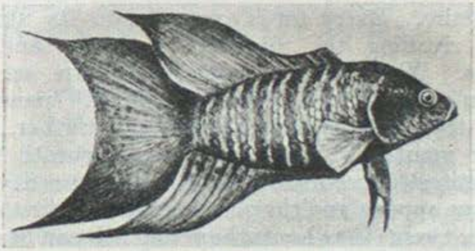
Paradise Fish (Macropodus venustus).

Male of the Paradise Fish in its normal condition and as seen in its native habitat. Pen cannot describe Nature as seen in these radiant beauties moving about during the procreative season.

Black and white illustrations cannot give an adequate idea to anyone who has not seen the beautiful colours of the male Paradise Fish

(*Macropodus venustus*) and the wonderful changes domestication has wrought in the form and coloration in this fish.

The next illustration will give a faint idea of the change that takes place. This is the same fish only showing its form with every fin expanded, the whole fish tremulous with emotion, and every marking most lustrous. The first ray of each ventral fin terminating in a sharp spine, its dazzling sheen and sparkling eyes, with its gill covers expanded, give it a resplendent appearance. This is only seen during the period of love, courtship and matrimony. Every marking is intensified and his eyes are aglow with excitement. The rainbow colours and tints he assumes are beyond description because they are ever changing. Not so with the females. These, during the same period, are of various shades of dun, sometimes dove-colour, at others a swarthy brown. Before and after the season of lovemaking it is rather difficult to distinguish the sexes.



**Male Paradise Fish (under domestication).**

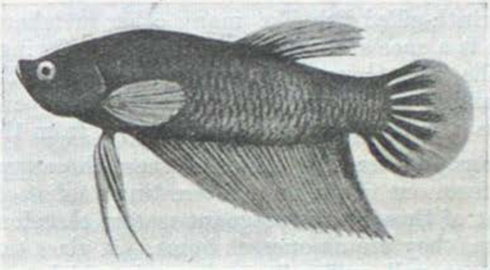
Their nesting habits will fascinate any lover of nature, and, as a study, cannot be surpassed. They are in no way shy under the gaze of a dozen pairs of eyes, providing their home be not disturbed. The male, having selected his consort, drives her to the farthest part of the aquarium wherein she must lurk. It is well to place a small piece of rock behind which she can hide. Why she so obscures herself I cannot tell. The male selects the nesting site on the surface of the water among the floating weeds, and at once sets to work to construct a nest. The material for its construction is composed of air-bubbles, which exude from the mouth of the male only, and are of a viscid nature. These continue to increase in number till they form a mass of about half an inch in thickness, and about two inches in diameter. Its construction occupies two or three days. All this time away down in one corner of the aquarium is the bride elect, sombre in coloration, her pectoral fins quivering with excitement as she intently watches the progressive formation of the structure that is to become the home for her offspring. Coyly in her bashfulness she lurks behind an obstruction, and keeps out of sight of the male, who is to be the sole controller of their first home of the season, wherein he will collect the ova and the young brood that is to perpetuate the race. Her lord and master is jealous—not of a rival to his affections, but he is afraid she will come and disturb his architecture before the top stone is fixed. The female dare not come near the nest until invited by the male.

She continues to keep in concealment, now and again giving upward glances to note how the work of construction is progressing. Should she venture too near the unfinished structure, her lord and master unceremoniously drives her to a retreat. The work being completed, a signal is given by the lord or the lady, but in what it consists I cannot say. The lady then coyly emerges into view with tremulous movements, advancing with graceful curves and slowly; evidently full of misgivings, she nears the nest; when underneath her colours become somewhat leaden. The gaudy and beautiful markings of youth all disappear. Not so with her consort; he clothes himself in his most brilliant attire. Every fin is expanded to its utmost, quivering and all aglow, rivalling the rainbow in shades and tints of the primary colours. When the ova appear, they are set in motion by the water circulating in the evolutions of both parents. Instantly the male is on the alert. Darting hither and thither, he gathers the truant eggs by mouthfuls, placing them underneath the nest. The spawner then retires to her little den. In about twenty hours the eggs eye, *i.e.*, the eyes appear, and the young exhibit the first signs of vitality. In about another twenty-five hours the young fish can be observed by the naked eye moving under the viscid matter of the nest. They have still the yolk attached. When about four or five days old it is absorbed.

The female has to retire, and it is as well if she be removed from the aquarium. The mothers cannot be trusted with their young. Notwithstanding all the watchful care of the male, she will often take a young fish, and dart away to her lurking place. When the young are old enough to wander around the nest, the whole of the father's vigilance is wanted to guard them from real or imaginary enemies. So anxious is he that if a finger be placed near the nest he will attack it and ofttimes spring out of the water to meet an approaching enemy.

### THE FIGHTING FISH (*Betta pugnax*).

The Fighting Fish are more commonly known as *Betta pugnax*. They are first cousins to the Paradise Fish. With both the Malays and Siamese these are greater pets than the Paradise. By these people *Betta pugnax* is only admired for its great fighting endurance. The fish are selected and pitted one against another for the so-called sport of combat. Like the game cocks of old, they are kept in solitary confinement in glass bowls until the day comes for the pitched battle, when they are matched the one against the other. It is when the two males meet that they show off their form and coloration

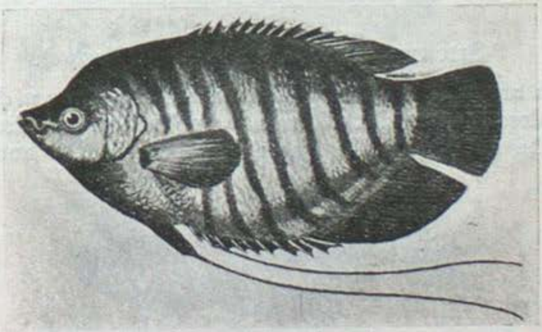


**Fighting Fish (Betta pugnax).**

The excitement of the onlookers is as great as it was at the old-time bull fights. Bets are made in regard to the victor.

### GOURAMI (*Osphromenus gourami*).

The Gourami, the Paradise fish, and the Fighting fish (*Betta pugnax*) are all very near relations, members of the *Anabantidæ*. The first form a magnificent addition to any collection of aquarium fishes. Like their brethren, they are natives of Cochin China. They are nest builders. In the Paradise fish the first ray of each ventral fin finishes in a sharp



**Gourami (Osphromenus gourami).**

spine. In the Gourami the first two rays of the ventral fin are continued in a long slender filament reaching some way beyond the caudal. It is chiefly herbivorous and is fond of nipping off the tender shoots of growing plants. The rootlets of the duckweed (*lemna*) are always acceptable to it. Nevertheless it does not disdain mosquito larvæ and aquatic insects. Clear water and plenty of weeds are the natural conditions suitable.

It is a labyrinth-gilled fish like many other members of this family group. There is a special formation of its gills. Owing to this formation in the gills, the Gourami is very tenacious of life and has the power of remaining out of water for a fairly long period. This gill cavity contains a fairly good supply of oxygen from the atmosphere.

The conditions and breeding habits of these three types are one and the same and form one of the most interesting studies of fish life. The natural habitat of these fish is stagnant water; therefore, when placed in an aquarium, they are at once at home. A glass tank, with about a gallon of water, will suffice for a home in which to propagate, if it contains the necessary health conditions.

During the winter season these fish are gregarious, and many of them will live peacefully in the same tank during that season. When spring arrives they should be paired. In the summer months, if not so separated, they become unsightly. Their mode of revenge is to rip the fins, pull off the scales and otherwise render themselves disagreeable to the eye. Those hatched in early spring will breed at one year old. They are content, do well and breed in small vessels. If so kept, as soon as the young are hatched they, or the parents, should be removed. It is much easier to remove the parents. In doing so care should be taken that the frothy nest be not destroyed, as for the first few days after they are hatched this froth forms their earliest food.

### STICKLEBACKS (*Gasterosteus aculeatus*).

These fish are nest builders. Their nests are quite a different type to those already mentioned, not a collection of frothy matter placed on the surface of the water, but constructed and built more after the manner of that of a bird. These nests are so different from those of the Paradise fish. Sticklebacks construct their nests at the bottom of the water wherein they are found. With this fish, as is always the case, the male is the nest builder; he selects the site and

**Three-spined Stickleback.**

prepares it; he erects the structure, the female taking no active part until the nest is ready to receive the ova.

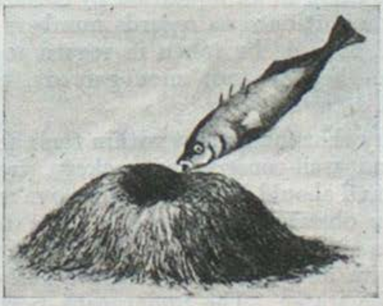
The Stickleback, when fully grown, is seldom to be found over two inches in length. The nest he constructs is about three inches in diameter at the base, conical in form and the apex is roughly finished. It is hollow, the cavity being deeply dished. This is the repository in which the female places her ova. The male is most watchful over his little home and its contents. Before the ova are deposited he is most anxious as regards the solidity of the structure, putting it to many tests. The final stage is the placing of it in obscurity by covering it with sand.

Sticklebacks (*Gasterosteus aculeatus*) should never be associated with other fish. No matter how much room there may be, the male will want the whole of the space for himself and mate, and finally she will have to give place. The writer once placed a few of these fish in a well stocked aquarium, and in less than forty-eight hours there was not a perfect specimen to be seen therein.

As the breeding season draws near the colouring of the male becomes more and more iridescent. Beautiful as he may be, he is too troublesome for any collection.

*Nest of three-spined Stickleback.*

So far in this State nest-building fishes have not been met with, if we except the catfish. Clearing a space and then heaping together a few pebbles is the nearest approach thereto. The few nest builders that have been introduced here have not yet found a permanent out-door home.



Three-spined Stickleback and nest.

The Paradise fish and its congeners are foreigners; they have made themselves at home under captivity, and the time is drawing near when these little nest-builders will become indigenous in the waters of this State, but not so with the Sticklebacks.

# Chapter VII.

## AMPHIBIANS.

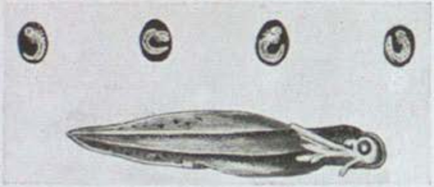
Japanese Fire-bellied Newts—sexes, habits, moulting the epidermis, breeding habits; Frogs — Procreative traits and metamorphoses, sexes, their courtship; Fresh-water Tortoises.

### JAPANESE FIRE-BELLIED NEWTS (*Molge pyrrhogastra*).

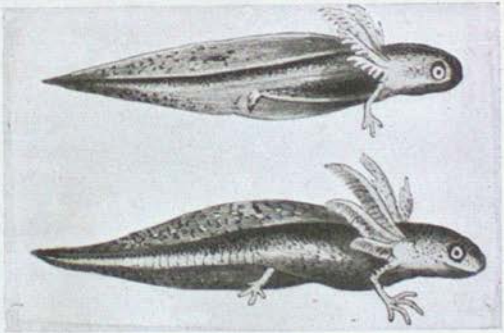
There are no newts indigenous to Australia. Those exposed for sale with gold and other fishes are the Japanese fire-breasted ones. These are very beautifully marked amphibians, and, as may be naturally supposed, are distinct in every particular from the other inhabitants of aquaria. Their habits are terrestrial, only that a large portion of their lives are spent in the water. All the functions of life are carried on in it. They breathe atmospheric air, and must come to the surface of the water to obtain it. They can live out of water almost as well as they can live in it, and are very fond of taking air baths, therefore their artificial homes should be constructed keeping that end in view.

It is well to keep them in an aquarium by themselves. If the sexes within it are well proportioned as regards numbers they will multiply, but much care will have to be taken in regard to the rearing of the young. In mating they are not monogamous, but communistic, to use Sir J. Lubbock's term.

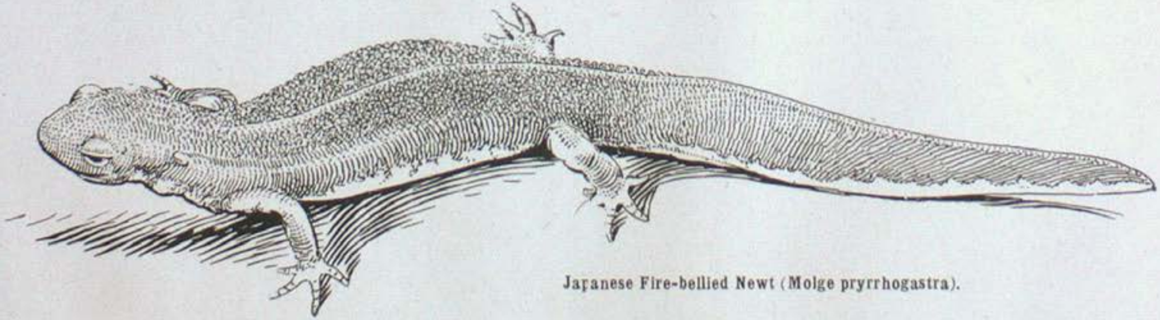
It is very necessary that the fittings within their artificial home should have an ornate and well-constructed rockery, free to access on all sides, so that the hand should be enabled to move around and keep the glass sides free for observation purposes. The top of this rockery must be at least one inch above the surface of the water. It should be flat and built with an irregular and rugged surface. Newts love to lie about out of the water. The underneath portion of the rockery should be open, giving free ingress and egress. All its sides should contain cavities and overhanging projections. Newts love lolling on such projections and crawling into and looking out of crannies. Their movements are by no means lively. In addition to a rockery there must be a goodly supply of *anacharis*, *vallisneria spiralis*, and other submerged water plants. I have used the word submerged because the little animals are very fond of crawling up the stems of aerial plants and getting away.



Metamorphoses of the newt from the embryo to the budding of the forelegs.



Metamorphoses of the Newt, showing the development of the gills and legs.



Japanese Fire-bellied Newt (Molge pryrrhogastra).

Newts are very interesting, although of slothful habits. Black and white can in no way portray the vivid markings so beautifully contrasted in this foreign amphibian. The name "fire-bellied" may convey some idea of the fiery coloration of the abdomen; a description in words, however exact, can only outline the variations of its brown back and the glowing red of its belly, the latter being interlaced with brown bars and maculations. The red markings on the female are far more conspicuous and much larger than those of the male. She is a much bigger animal; is longer and of greater girth, and her tail is broader and flatter. During the breeding season her back in colour is a velvety black, and the shades of her abdomen are much intensified.

The chief differences between the sexes are that the male is only about two-thirds the size of the female, the mottled orange markings are more subdued, and the black interlacing lines are nearer together and very much smaller than the corresponding marks on the female. His tail is narrower and more compressed, and there is a very slender continuation thereto.

The black shining backs of the newts, their orange breasts, their quaint movements, their habit of crawling out at the end of a blade of *vallisneria*, holding on by their two hind feet and suspending themselves thereby mid-water, so unlike other denizens of aquaria, give them a distinctively alluring and inviting appearance.

Here is an interesting feature in their life-history. They have the power of renewing, like birds, their youthful appearance. Birds change their plumage every year, newts change their skin once and sometimes twice a year. They do not throw off their old dress a bit at a time as birds do; they remove the whole epidermis as we remove our gloves. This outer skin loosens round about the mouth. They then gradually draw themselves out of it right down to their toes and the very tip of their tail; thus the skin turns inside out. Sometimes they become cannibalistic, eating their own eggs, young, and even their own cast-off skins.

Their empty skins should be preserved. This may be done by lifting them out of the water with a small camel-hair brush, placing them on a piece of white cardboard, and brushing them out in their natural form. They will keep their form, the empty skins being adhesive.

There is another remarkable natural power possessed by these amphibians, that is, if accidentally they should lose a limb, and I have known that to occur, Nature sets to work to repair the damage. Newts are by no means pugnacious, but sometimes when feeding and scrambling for the supply of food given they fail to take the morsel they aim at, they inadvertently seize a limb of a competitor. In the tug of war following thereon I have seen the limb lost, and nature has in time replaced it. Similar incidents occasionally happen among some crustaceans. The maimed newts appear to suffer little or nothing from the damage inflicted.

The student of nature will find in their breeding habits far more interest than in their every-day life. Their metamorphoses can be seen so clearly and every change noted from the production of the ovum to the birth of its inmate. Watch the mother newt cautiously selecting a leaf of a submerged plant, deposit an egg thereon, carefully enwrapping it so as to hide it from the eyes of prowling feeders.

They are very partial to leaves of *vallisneria*; where the female finds two leaves close together she will place her egg between them. Again, she will lay an egg on a leaf, then draw another leaf carefully over it for concealment. Two eggs are never deposited together.

Where an egg is found convenient for removal the student of nature will have this reward. The egg should be secured as soon as found. Those deposited on leaves that are fairly free from obstruction should be put in clear glass bottles—ordinary doctor's bottles are just the thing—the others may be placed in any kind of vessel; but, wherever put, both leaf and ovum must be well submerged. Those in bottles are for observation purposes. Put three or four in the bottle, placing the eggs as near to the sides of the bottle as convenient. The bottles or other vessels must be put in a sunny aspect. Don't permit the direct rays of the sun to fall upon them. In about fourteen days, if all local conditions are favourable, that is, light and temperature, the egg cases will be seen empty and the baby newts can be seen hiding between the leaves. Don't finger them until they are seen to be crawling about.

The student of nature will be well repaid for the time he spends in his observation of these eggs. When the ovum is first deposited, the embryo within will be globular for the first three or four days, then elongation will take place; first the head with the eyes will be visible, then the bronchi or gills, the little inmates having the appearance of fish. With a microscope the blood circulation can be readily detected. The tadpole will be seen to be very restless and making efforts to escape. When out of the egg-case they are at first difficult to find. A little bright eye peeping from beneath a covering where they have gone for protection will be the only indication that they are there.

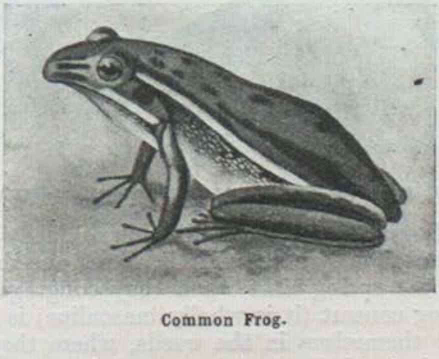
Newt tadpoles are very dissimilar to those of the frog. The tadpoles of both these amphibians have claspers, that is, little hooks by means of which they move from place to place. The first organs of propulsion to develop in the newts are the two forelegs, but with the frogs it is the two hind ones. With newts the claspers give place to forelegs at a very early stage.

The first food of tadpoles consists of the larger varieties of microscopic animalculæ, then mosquito larvæ. The tadpoles are semi-transparent till two or three months old. During this stage in their growth, by looking at their abdomen externally you can see if they have had their breakfasts. As they hatch out they should be removed from the observation bottles for feeding purposes, and, as soon as the external gills have been absorbed, they will be seen clambering to the surface of the water to breathe the atmospheric air. As in the case of the old ones, with every mouthful of air they take, they produce a popping or gurgling sound.

The metamorphoses of newts always give to students a succession of field days, for they include not only the transformation of newts but those of frogs, and to a large extent in the early stages, those of fish.

## FROGS.

Why are frogs so disliked? Certainly to the touch they have a cold, moist, clammy feeling, and their note, which is only uttered by the male, is not in all cases quite musical, but a book on "Aquarian Nature Studies" could not be considered complete unless some details of the life history of this common amphibian were included, although their habits are almost analogous to those of the newts. If newts are in no case indigenous in this country, their absence is made good by the number of varieties of the frog family.



Common Frog.

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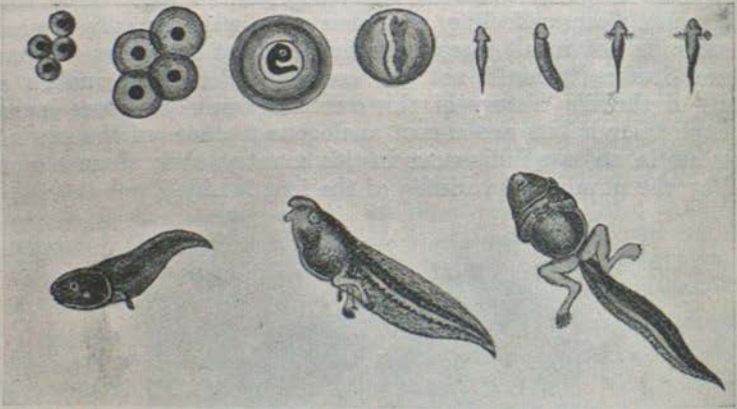
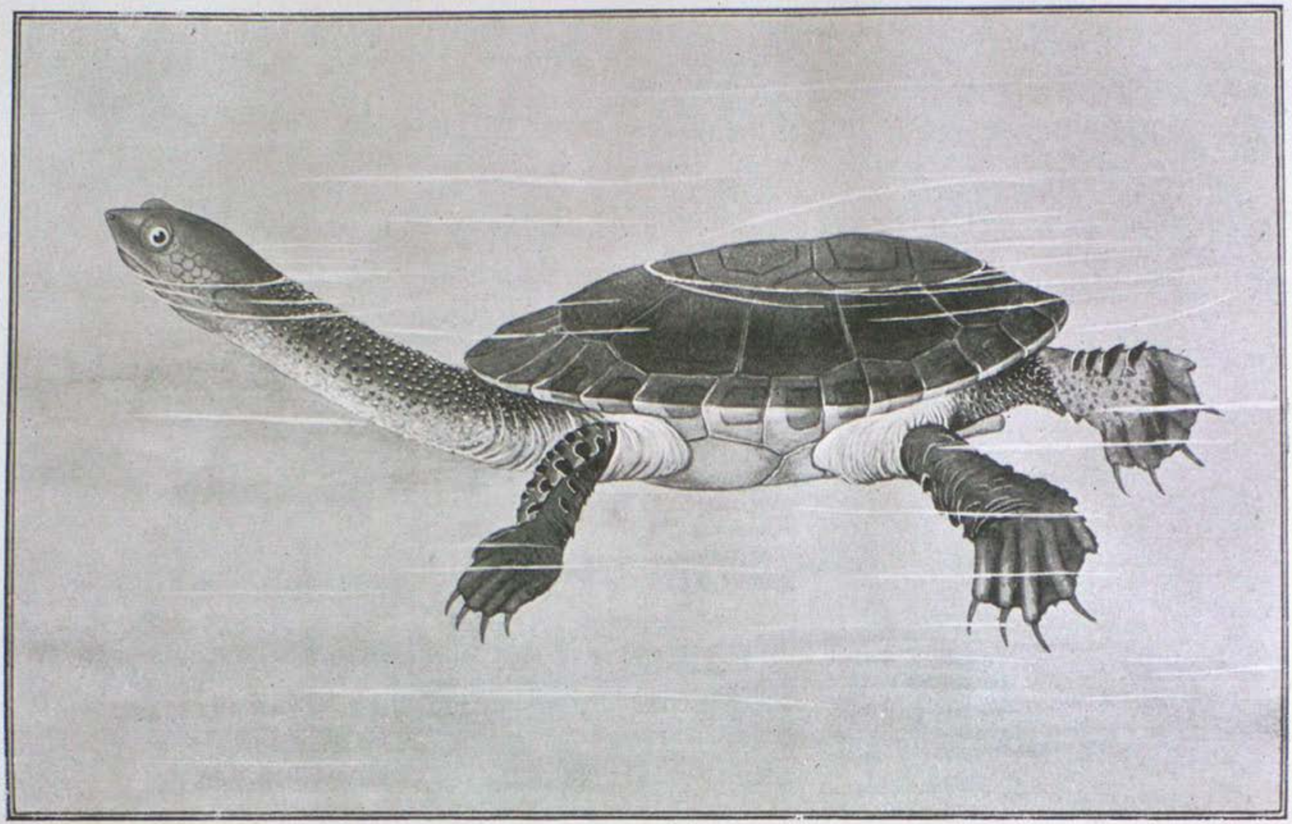
The life history of frogs is fraught with much interest if only their metamorphoses be studied. The spawning of frogs differs greatly from that of newts in that the former deposit their ova in a shapeless mass, exposed to full view and in no way protected, whilst the latter deposit their eggs singly, obscured from view and well protected. Frog-tadpoles when first hatched have, for the first few days, no mouths;

they live on the egg yolk and breathe by means of external gills. About the third day the gills disappear by being absorbed into the system. As the external gills become absorbed internal ones take their place. Their appearance now becomes fish-like, their mode of propulsion, their mode of breathing, their whole semblance and movements are those of fish, living wholly under water and feeding on vegetable matter. The next change seen in their transition is the budding of their hind legs (with newts the forelegs are the first to bud); these are at first only little knobs. They can be seen at the anal extremity, where as the legs grow it will be seen they have three rear appendages, two legs and a tail. The next transition is the budding and growth of the fore legs. Now the little fellow appears to be more of a quadruped with a long vertically flat tail, than a fish. As the external gills become absorbed, so now the tail, by absorption, aids in the nutriment of the trunk, and gradually disappears. The tail does not drop off as is generally supposed.



Metamorphoses of the Frog from embryo to the four-legged Tadpole.

The sexes of frogs are somewhat dissimilar, chiefly in the shades of colouring and size of body; the male is about one-third smaller than the female. In the spring time when they congregate in the water-holes and the frog concert (it is wholly masculine) is in full blast, the songsters secrete themselves in the weeds, where they can readily be seen (if you remain motionless) giving out their sonorous croaks. This music acts as a charm to the females. The females are captivated by the serenading of the lords of the frog creation and are accepted as consorts for that season. The female being the more muscular of the two condescends to transport her liege lord and master from place to place around her watery domain upon her back.



Fresh-water Tortoise.

The thumbs of the male of the Australian frog, in spring time, become elongated into spurs (the thumbs of European frogs are knobs). When he is comfortably seated to take his aquatic excursions and to avoid accidents, these spurs are placed into two little cavities under the arms of the boatman, who has taken it upon herself to transport him from place to place whithersoever she listeth. These grips make his security doubly secure against being ruthlessly dislodged by jealous rivals. Thus the frogs' concert and the frogs' consort come to an end for that one season.

### FRESH-WATER TORTOISES.

There are several varieties of these very interesting and unique reptiles. To a casual observer they have no backbone or ribs, in fact they appear to be boneless; indeed they have no internal skeleton. All their bony anatomy is contained in the covering usually termed the shell. Some varieties are amphibians, others are dwellers upon the land, others again are wholly aquatic. All reptiles are oviparous. Those tortoises that are amphibious or that are wholly aquatic visit the coast-line of the seas annually for the purpose of depositing their eggs; these are buried in the sand and are hatched out by the heat of the sun. So also land tortoises find their way to the seashore for the same purpose. Most of these amphibians are too cumbersome for aquaria purposes.

The most suitable for an aquarium of ordinary size are the soft shell species. These are only to be found in the warmer regions of Asia and Africa. Frequently there are some of the soft, leathery shelled fresh-water tortoises to be met with exposed for sale in the bird-shop windows in Sydney.

Their mode of life adapts them as companions to the Japanese fire-breasted newts. The same structure of aquaria and the same food are very suitable. Nevertheless, when the newts are spawning they should be removed to an independent vessel; otherwise, the eggs of the newts will soon disappear. As a change of food a few earthworms now and again will add life to their slow movements.

# Chapter VIII.

## SCAVENGERS.

Aquaria Scavengers: Pond Snails—reproductive habits—queer hermaphrodite changes—rapid increase—peculiar modes of transport—Mussels, Shrimps, and other Crustaceans (their sanitary value).

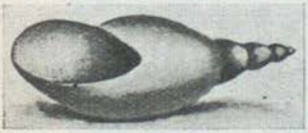
### Pond Snails.

I do not know which is the more to be condemned, an aquarium without submerged aqueous foliage or one having no pond snails. It is the combined action of these two accessories that gives health to the fish. The preservation of health is the most essential factor for the longevity of both the vegetable and animal specimens of an aquarium. Health can only be maintained when the sanitary conditions are fairly perfect. Aids to health must be studied in all details. How the removal of deleterious and decomposing matter is to be accomplished to keep the water free from contamination is as much a nature study as that of the plant life or of the other inmates of the aquarium.

Nature has provided scavengers in order to keep her many children clean and free from disease germs. The great sanitary scavengers are the too often discarded pond snails. They are very abundant in all waterholes and sluggishly flowing rivers. The life history of these molluscs is very intricate and their method of reproduction is no less so. They are hermaphrodites. They increase with great rapidity. A half-dozen placed in an aquarium wherein there are only herbivorous fish will be quickly stocked, though the latter will often prey upon them. The jelly-like masses of spawn will be found deposited on the under surface of any submerged object and on the side walls of a glass aquarium. When thus deposited these jelly-like masses are fairly transparent, and the interesting transformation of the larvæ can be seen with an ordinary hand lens. The first indication of life in the ovum is a small black speck in the centre of the egg sac; when this breaks the young are set free. If some care be not exercised many will not be suffered to live to maturity. They are tempting mouthfuls for any fish, young or old. If the under sides of the leaves be searched the little jelly-like masses are easily seen, or by passing a blade of *vallisneria* between the finger and thumb they can be felt. Take these jelly masses that are attached to the leaf and put both eggs and leaf in a bottle of water; put the bottle and its contents in a suitable situation, and they will hatch out by the dozen. Their food will be the decaying leaves on which they were hatched.

Here are interesting phenomena:—A little mollusc will be seen crawling along the water-film, its body suspended underneath; the only fulcrum it has is, apparently, the air above the film, yet he moves as freely as though crawling on a leaf. Suddenly he will lower himself gradually to the bottom and after a time he will as slowly ascend. He appears to have no foothold. This is one of nature's wonders. Here is the explanation of the marvel. These pond snails possess spinnerets, by means of which they spin gelatinous threads; there is a small cavity at the upper end of the thread, almost invisible to the naked eye. These concavities act as small boats and thus the snails are suspended and enabled to ascend and descend at will.

Always keep snails in aquaria. In addition to their use as scavengers, there are many nature studies connected with them.



**Limnæa stagnalis.**

**Limnæa auricularia,**

These two varieties of snails are found plentifully in the waterholes of New South Wales.

## CRUSTACEAN SCAVENGERS.

If we take a small hand net and drag it through the weeds in any waterhole or along the margin of any fresh-water river hoping to obtain specimens for our pet aquaria, if all other specimens fail, we are sure to obtain a goodly supply of fresh-water shrimps. Don't discard them. As scavengers they are equal to the pond snail. The pond snails remove decaying vegetable matter. The common shrimp removes all decaying animal matter. The snails and mussels die and decompose within their shells, and become aids to polluting the water. In form the shrimp seems to be ordained for this kind of scavenging. If you have a tank wherein many snails have been reared, in the early springtime you will note many empty shells. What became of the dead carcases? It is the work of these scavengers to remove them. These and the small carnivorous fish are the only agents at your disposal to take away the snail carcases from their coffins. There are always plenty of hungry inhabitants to make a meal of them when once they are removed from their shells.

The home of the shrimps is in the sandy soil and débris at the bottom of your tanks. Herein they burrow and hide during most of daytime. If you have any rockwork with aquatic weeds growing thereon, shrimps delight to make it their home. Their semi-transparent bodies seen gliding over the conferva-covered stones, the little cloud of sand they throw over themselves in hiding, their eggs carried between their legs, and their peculiar mode of propulsion are all interesting and instructive.

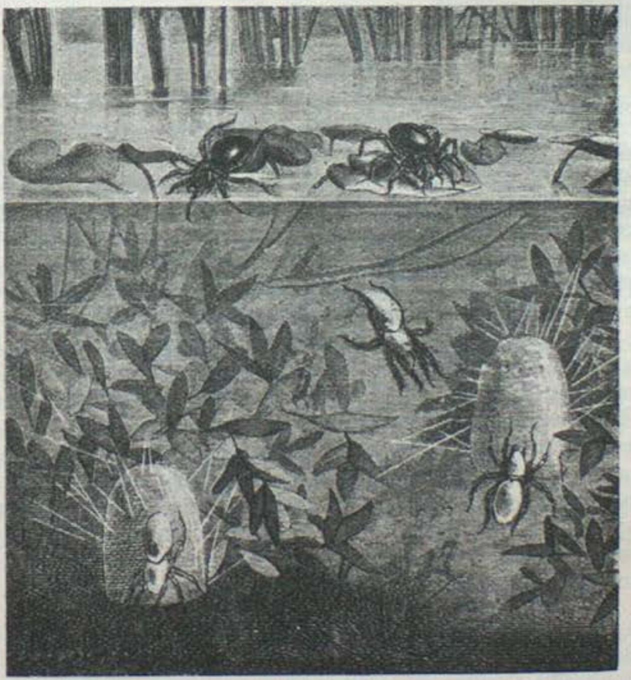
# Chapter IX.

## WATER SPIDERS.

### (*Dolomedes facetus.*)

Water Spiders (*Dolomedes facetus*): Description of the sexes—Canni balistic habits—Movements on the Water-film—Nesting—Their cobwebs.

These are very interesting specimens of aquatic life. Upon near inspection they will be found to repay all the time devoted to watching their unique habits. Their walking and running along the film of the water; the entangling of a supply of air in the abdominal and other hairs of their body; the construction of their subaqueous nests and their daily habits both above and in the water; their ingenuity and intelligence, form such a series of nature studies as must inspire zeal in any student of nature.



Water Spiders running on the water-film, and their submerged nests

They are generally to be found among the weeds in the still waters along the sides of the rivers and in lagoons. The oval body of the little fellow is not more than half an inch long, but its eight hairy legs give it a much larger appearance. Its abdomen is a dark chocolate. The common rule in the spider family is that the female is the larger; in this family she is the smaller. It is an interesting sight to see her fabricating the walls or sides of her diving bell. Of course the web is water-tight. To see these spiders in all their active every-day work they should be housed by themselves. Aquatic beetles, pond snails and other water animals too frequently destroy their diving bells. A tall clear glass lolly jar, if well stocked with *Vallisneria spiralis*, makes the best of jars for observation purposes.

Water Spider
(Dolomedes facetus).

These water spiders, like their terrestrial brethren, are somewhat cannibalistic. While the diving bell is being constructed the female must not approach it. The penalty for being too inquisitive over the structure is death. The widower's mourning is of short duration; he is soon consoled by the attentions of another admirer.

While nesting they must be fairly well supplied with food. Mosquito larvæ and other aquatic insects are their natural prey. Put the glass vessel in which they are kept, out of the direct sun rays; there will then be no danger of the view being obscured by the growth of confervæ. Cover the vessel with a piece of glass; the little fellowr are fond of wandering about in the quiet eventide. The nest is about the size of a thimble. A threadlike web is constructed between this little dome and an anchorage on the surface of the water. This is for the purpose of ascending and descending with globules of air wherewith the nest is filled. The spiders will be seen moving up and down like silver balls owing to the air that is entangled in the hairs of the body. When all things are ready the eggs are deposited in the little diving bell. These eggs are enclosed in a water-proof cocoon and made fast by means of cobweb cords. It takes about fourteen days for the eggs to hatch. As soon as the little fellows emerge into daylight they begin to build their own homes. A constant supply of oxygen is kept up by the parents ascending and descending the communicating thread between the nest and water surface.

# Chapter X.

## WATER INSECTS.

**Aquatic Insects: Water Measurers, Water Scorpions, Water Beetles—Water Boatmen (mode of propulsion, habits)—Beetles, Whirligigs (aquatic, aerial, and terrestrial habits)—Water Tigers (larval stages, life history)—Caddis Worms, metamorphoses of—Case building—Material used.**

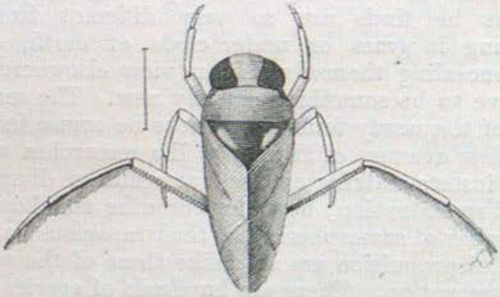
In walking and searching the waters along the margins of rivers and waterholes the student of nature will be sure to find a new world of insect life, very unlike the insect life he has been in the habit of seeing and capturing on the dry land. The specimens he finds are so very different from those he discovers lurking in grass or under clods of earth, or hiding in crannies or concealing themselves from view elsewhere. His observation will have to be something entirely new. The movements and every-day life of the newly found specimens he comes in contact with will open up new avenues of thought. His researches will bring him in touch with insects walking on the water film or diving beneath it. Their mode of reproduction; how they breathe and how they obtain their fresh supplies of atmospheric air; their rapacious habits and their various modes of propulsion are so unlike those of the various insects of our daily observation. There are hundreds of species and varieties of water measurers, water scorpions and water beetles. Some of them are very beautiful, but are far too rapacious to be kept in close confinement with scarce or choice varieties of fish. Some are useful as scavengers and others browse on the rapidly-growing confervæ. Such insects are very useful in open waters, but from the confined space of small aquaria they should be excluded. Nevertheless, there are two or three species worthy of lodgment in an aquarium if only for their beauty. Others may be admitted on account of their graceful movements, and again others to exhibit to the student how they live and move and breathe.

### The Water-Boatman (*Enithares bergrothi*).

Like all true insects they have six legs. The two outer ones are feathery, being fringed on either side with flat hair-like appendages. These outer legs are much longer than the other four. These feathery legs are their sculls, by means of which they row themselves from place to place. In their mode of propulsion they are the most curious of all water insects. With such a pair of broad sculls they are equally at home either upon or under the water. They have long beaks, and with these and aided by rapid strokes, and by acuteness of sight, they easily take their prey, be it a tadpole or small fish, catching it with their claws, and as the victim carries them from place to place, these boatmen suck out the soft portions of its body.

Their locomotive powers are wonderful; not only are they at home in water, but equally so in the air, or on the bottom of the river crawling on the mud

As aquaria specimens they look well when six or eight of them are together (they are gregarious). They always swim upside down. They are expert divers, and if disturbed they are soon out of sight. Their general tint is yellowish with a triangular black mark on their backs. Their bodies are covered with short black hairs. In diving they carry down globules of air with them. These globules give them a silvery hue, and a very marked appearance when seen playing among the weeds. With their sharp bills they bite acutely, and care must be taken in handling them.



**Water-boatman (Enithares bergrothi).**

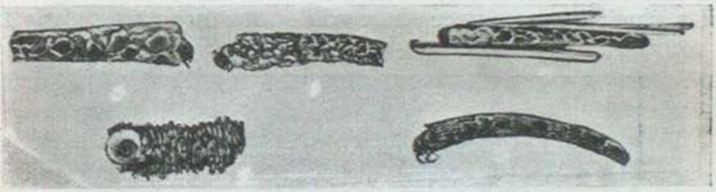
There is not much otherwise to be said in their favour. A separate section of the aquarium should be devoted to them on account of their rapacious habits. They quickly attack and kill most other animals that are stocked with them. Nevertheless, there are these things in favour of them—they have beauty and activity on their side. Their mode of respiration is by taking down a supply of oxygen beneath the water with them; at frequent intervals they rise to the water film, extrude their abdomen, open their wing sheaths (elytra), expand their membranous wings, gather in the oxygen, and descend with it. Their specific gravity is low, therefore they have recourse to taking frequent rests in their descent.

Their bodies are very boat-like in shape; along their back is a deep keel. As they swim on their backs with their pair of oars extended, their resemblance to a boat becomes intensified.

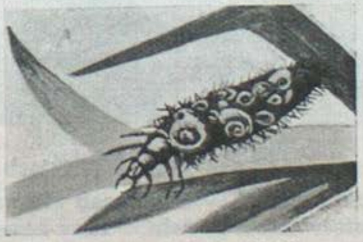
The top of their compartment should be covered with glass, as they are very fond of taking aerial excursions.

## CADDIS-WORMS.

Caddis-worms are the third stage in the metamorphoses of many insects, both terrestrial and aquatic. Their fourth or imago stage is not aquatic, and, otherwise than as food for fishes, is of little interest in the aquarium. The depositing of the eggs that produce the worms and their constructing for personal protection the little castles, wherein they encase themselves, are the chief and only interest in watching them. The female lays her eggs in the water while resting on the film and sometimes carries them from place to place seeking for a suitable anchorage. In a few days these eggs hatch and the young remain in the jelly sac for two or three days. No



**Caddis-Worms** Larvæ of different species in their cases.

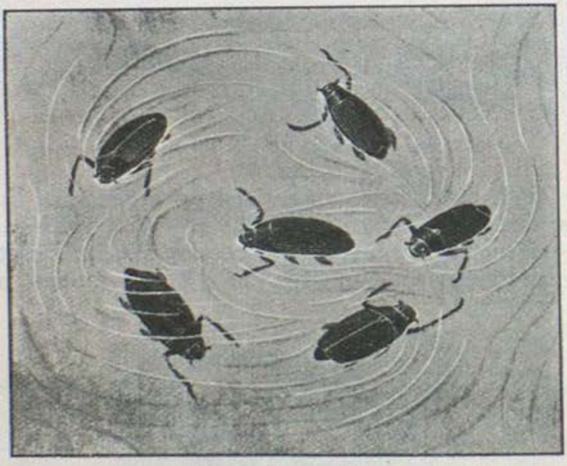


Caddis-fly larva in case feeding.

sooner does the inmate quit this sac, than it at once instinctively searches for building material wherewith to build its harbour of refuge. The building material consists of sand, bits of shells, sticks, leaves, anything; sometimes the small shells of pond snails containing their living inmates are utilised. But these little castles are not invulnerable, and often become a prey to the attacks of water scorpions, and the inmates quickly become a meal for them or other carnivorous insects.

### BEETLES—WHIRLIGIGS (*Gyrinidæ Latreille*).

Whirligigs belong to the family Macrogyrus rivularis. They take their name from their constant whirling evolutions and their lively gyrations. In the old land we know them by the name of "Shiners," on account of their sheen. They are gregarious. When two or three dozen of them congregate together on the water film, their black shining little bodies are very interesting while they perform their tango dances, but if a shadow passes over them while thus disporting, their frolics come to a sudden end and they disappear without giving any notice. To search for them after that is in vain. They have dived to the bottom of the waterhole and are hidden in the sand. They are generally to be seen sporting in still waters.

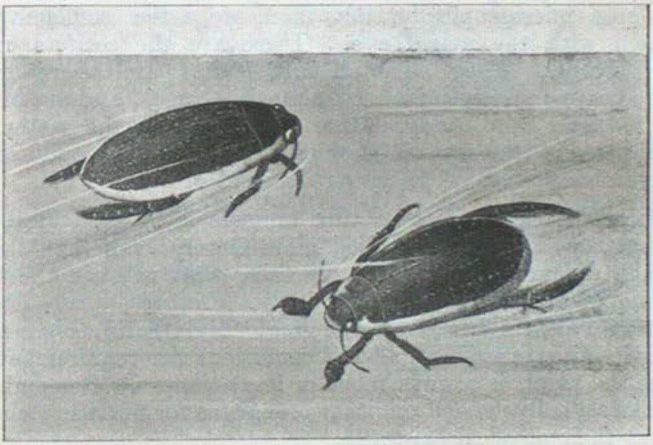


Whirligigs (Gyrinidæ Latreille).

If kept in a fairly large sized aquarium their movements are readily observed. They are rapid fliers, and on that account they must be covered with a glass lid.

## WATER TIGER (*Cybister tripunctata*).

Water tigers are among the largest water coleoptera to be met with. They grow to about 2 inches and are broad in proportion. As an aquarium specimen the most interesting feature is their peculiar mode of respiration. They do not obtain oxygen from the water as true aquatics always do. These beetles breathe atmospheric air from the surface of the water, and their manner of obtaining it is very unique. Their breathing tubes are hidden by the wing-sheaths, which when closed form an arched chamber, which is watertight. When they wish to obtain a fresh supply of air they protrude the anal extremity of the abdomen. As these beetles swim about in the water a globule of air is always to be seen attached to the anal extremities. Their specific gravity being lighter than water, they are compelled, when not swimming, to anchor themselves to some stationary object to keep themselves beneath the surface. They are to be seen floating about near the surface of the water and always in pairs. The male is the larger insect of the two. In the male the front pair of legs have flat feathery knobs attached thereto, and the hindermost are more feathery than those of the female.



Cybister tripunctata (male and female).

It is in their larva stage that they are known as " Water-tigers " or " Water-devils."

# Chapter XI.

## SOME ANIMALCULÆ.

Some Animalculæ and Water Worms: (*a*) Rotifers (great fecundity and rapid growth of)—(*b*) Nematoid Worms: Habits—Valuable as fish food.

The great majority of these small specimens of animal life can only be seen microscopically, but there are a few sufficiently large to be seen with the naked eye. These are the rotifers and the nematoid worms. They have all soft bodies, and therefore come under the common designation of "aquatic worms," and are of special interest to those who study nature that is under the water. It is these animalculæ that sustain the upkeep, the health conditions, and the procreative powers of the larger denizens of aquaria life.

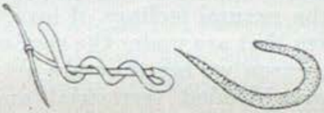
The economic value of these tiny animals is of such vital importance, that they should be studied more closely even than the other inhabitants of our water tanks. Nothing that will aid the laws of nature should be passed over slightingly. Nature, who so tenderly looks after all her children, from the great "leviathan" to the smallest microscopic mite, must have all the conditions her requirements need, otherwise the result is always more or less a failure. Remember that all organisms wholly depend on other organisms for nutrition wherewith to support their physical existence.

### ROTIFERS.

These are generally wheel animalculæ. In the first description given of them a rotifer was said to be "an animal like a large maggot, on the tail of which appeared forceps like that of an earwig." The next description of it was "an animal with two wheels thick set with teeth resembling the wheels of a watch." These two descriptions taken together will help us to recognise them. The common rotifers (*vulgaris*) are 1-50th of an inch long; still they are the giants of the race. Of other members of the family, it takes 100 of them to the inch. They increase very rapidly. The female produces 50 young every thirteen days. The males live only three or four days, but the longevity of the females is from twelve to fourteen days. Increasing so rapidly they can afford to die off quickly. When once a few of them are put in an aquarium no further trouble need be taken. They breed in the mud, and unless an aquarium be overstocked with fish the supply of them is well maintained for the rearing of young fish in their first stage of growth. They will be constantly seen rotating in the water, and it is amusing to note the baby fish chasing and feeding on them.

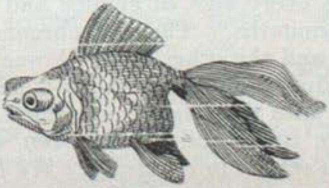
## NEMATOID WORMS.

These in appearance are very similar to the common earthworm. They fix themselves in the débris, live in colonies, and when once they make for themselves a home in the bottom of an aquarium they become extremely active. They have an oscillatory motion, and grow to about 1½ inches in length; fully a third of their length is used as anchorage. They are various shades of red. Their appearance is by no means repulsive.



Nematoid Worms.

Their chief advantage to an aquarium is that they are splendid food for the young carnivorous fish, and indeed for any fish. When the plant anchorage is constantly disturbed their increase is checked; therefore leave well alone, and don't disturb the plants.



# Chapter XII.

## EMOTIONS OF FISHES.

**Fish Emotions:** Love, courtship, and matrimony; monogamy, polygamy, polyandry, and communistic matrimony; hatred, malice, play, fear, affection, pride, anger; sexes among goldfish (carp).

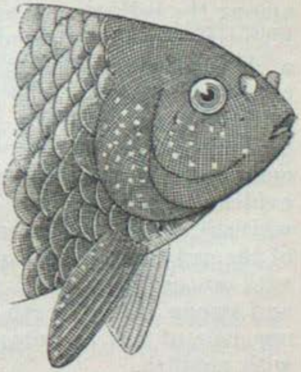
Have fishes sensibilities akin to those of warm-blooded animals? We know they have the natural feelings of love, courtship, and matrimony. If we watch fish that are under the confinement of an aquarium during the connubial season we see they are actuated in precisely the same way as are warm-blooded terrestrial animals. Each sex has its rivals in greater or lesser degree, and the period of courtship varies; sometimes it is lengthened into days, at other times it is "love at first sight." When there are several fish of one variety in the tank, and the sexes are not equal numerically, some are left unpaired, and the unfortunate ones are very soon worried and bitten to death. This is a trait with Paradise fish. As a rule these are monogamous, although on one occasion I saw a case of polygamy. Where fish live solitary lives their matrimonial traits differ from those of gregarious fish. Gold and other carp, as I have stated elsewhere, are communal. By their pugnacious characteristics we know they have the capacity of hatred and malice. Two male zebra fish, when separated one from the other by a sheet of glass only, will for days be striving for a combat. Should they by any chance get together, then begins a struggle for the mastery. First they view each other from a distance with every sign of enmity and rancour, approaching each other with open mouths. They soon become interlocked, the one is held by the upper and the other by the lower jaw; it then becomes a tug-of-war to the finish, unless there be a means of escape. That they are sympathetic with their own young there is ample proof. When in captivity they are timid and fearful even when generation after generation have been reared in captivity. We have seen them, when disturbed by a sudden noise, remain for a moment or so motionless, tremble, then sink to the bottom, gasp for breath, and with fins quivering die literally of fright.

In an aquarium the most interesting functions of fish life are lost to view if the law to "replenish the earth" be neglected. For without the patient investigation of the laws relating to procreation and the perpetuation of species, all written language relating thereto fails to enlighten the observer of nature's most interesting processes, how she works out her hidden secrets and at the same time reveals to the student how she "replenishes the earth."

Discrepancies exist between what is written and what is seen. Darwin, in his work "The Descent of Man," says "carp (*cyprinidæ*), appear regularly to follow the practice, rare in the animal kingdom, of polyandry—when a female carp comes amongst the males she is immediately pressed closely by a male on each side, and when they have been in that situation for some time are superseded by two other males."

Carp are gregarious and their courtship and marriage are carried on under communistic conditions. Darwin observed their gregarious habit only, but did not attempt to verify the necessity or otherwise of a male fish on each side of the female and their replacement by other two.

In the fructification of the ova, as is the case with most oviparous fishes where they are gregarious and marriages communistic, the female discharges the germs of matter (ova) and the male the germs of life (sperm), scattering them at random among the most suitable weeds that are on the surface of the water, the males always intermixing with the females. When these germs or cells of matter are once freed from the ovary, the male at once discharges the sperms or cells of life, which are microscopic. The cells of the ova and the cells of the sperms are rapidly churned up by the quick movements of the excited fish. This prevents them from at once adhering to the weeds (the eggs are glutinous). Each ovum receives one germ cell of life from the sperms through the little gateway, the micropyle, and that must take place before the fructified ovum has found a lodgment on the weeds or elsewhere; therefore, there is no necessity for the females to be pressed by the males.



**Head of male goldfish (milter) during breeding season**

Among the gregarious fish the males have no clasping fins, as is the case with some of the monogamous, or with some that are monogamous for one season only, especially those that are viviparous, such as the *Gambusia affinis*.

The males of the carp referred to by Darwin, as the breeding season approaches, develop excrescences on the gill-covers and pectoral fins. The function of these excrescences is wholly independent of the extrusion of the germ-cells, but serves a purpose that leads up to the maturity of the ova. That it is essential for two or more males to accompany a female to aid her to discharge her ova is not exactly the law of reproduction with other animals. If we test Darwin's written language with the facts as seen with this class of fish when confined in an aquarium, we note as the season of procreation approaches, that it is far from being so essential as he supposes, to have two males one on each side of a female. If an aquarium has all the healthy conditions necessary for the purposes of breeding young goldfish, a single pair of these is as certain of reproducing the species as a dozen of the two sexes intermixed would be.

The writer successfully tested this by practical proofs, selecting an aquarium containing all the health conditions necessary, and setting it apart for the purpose of observation. Choosing a mature male, *i.e.*, one showing the excrescences of maturity, also taking a female showing signs of reproduction, and placing them in company in the same aquarium, he observed that, as soon as the two fish saw each other, there was indicated love at first sight. On the morrow it was evident by their movements there was courtship in full swing, and an engagement soon followed. Two days later there was a clear understanding that maternity would follow. The two fish had taken to hide and seek among the *vallisneria* and *nitella* growing on the surface of the water. Knowing the glutinous nature of the ova of these fish the writer placed a sheet of glass under the water plants to intercept the eggs in their transit downwards. The plan was successful. In the evening the two fish were returned from whence they came. Removing the sheet of glass (scores of eggs were adhering thereto) and placing it erect about one-fourth of an inch from the glass front of the tank, it became evident there were only a very few infertile eggs (infertile eggs are whitish). The experiment resulted as anticipated. From the position of the ova on the sheet of glass, every change in the eggs could be seen with an ordinary lens. In eight days the young hatched out healthy and strong. The length of time differs according to conditions. No, one pair of fish is quite enough to aid in replenishing your aquarium with goldfish.

# Chapter XIII.

## USEFUL HINTS.

### Useful Hints—Fragments of Advice.

1. Every time you refill an aquarium, it is not necessary to do this by means of a syphon. If the anchorage, that is to say, the débris in the bottom, is composed as advised elsewhere, without clayey matter mixed therewith, just pour in the water with a common watering pot having a fine rose. The object is not to disturb the rootlets of the plants. The organic sediment will just be stirred up. It will be sure to receive a little disturbance in receiving a fresh supply of water, but it will settle in a very few minutes. Neither the fish nor plants will be any the worse.

2. If there be a good supply of submerged plants the water need never be changed. Before an aquarium can arrive at this perfection the plants must be in a good growing and healthy condition. It may take some weeks before the growth is properly established. The best time of the year to stock an aquarium with herbage is the autumn.

3. Do not place any animal life, pond snails excepted, in the water until the plants are firmly rooted.

4. The confervæ that collect on the glass sides should never be removed with sandpaper, no matter how fine it is. It will be sure to scratch it. Lower the water a few inches, then with a piece of old bagging damped, and slightly covered with table salt, the confervæ can easily be removed. The little salt that may fall in the water will do no harm.

5. Fungus is a deadly enemy to fish in confinement. A white fluffy matter will first show itself on the tail and pectoral fins. When showing itself in its earlier stages, remove the suffering fish to another vessel and place them under the drip from a water tap. Put common salt in the water. As soon as the fish are seen to swim on their backs, weaken the solution by adding more water. If it be not a valuable specimen destroy it or the trouble will run through the whole of your collection of fishes. The chief cause of the trouble is the unhealthy condition of the aquarium in which they are kept. Not only are the fish liable to this fungoid growth but all insects and animalculæ fall victims to it.

6. Avoid overcrowding with animal life. Far better have too few than too many. When the fish seem to be trying to breathe atmospheric air by bobbing their noses constantly out of the water, remove some of them and give a fresh supply of water. The cause is an insufficiency of healthy plant life in the water.

7. Amateurs in feeding their pets are always prone to overdo it. Feed regularly once a day. The quantity of food given must be regulated by the number of fish to be fed. Before feeding cast your eye around to see if any of yesterday's meal be left unconsumed. If so, take a glass tube about 18 inches long, and with your finger hermetically seal one end. Place the open end in the water directly over the obnoxious morsel, remove the finger and it will be seen to enter the glass tube. All deleterious matter can be removed in the same way. If yesterday's meal be not consumed, the next day should be considered a fast day. A fast day is highly beneficial, say, once a week.

8. Fish when in a playful mood leap from the water and fall outside the tank, thus committing unintentional suicide; the pond snails crawl out; dust and rubbish fall in; and children's fingers and cats' claws disturb the inmates; avoid such accidents by placing a sheet of glass over each aquarium. It is safer if the glass be framed to prevent the accident of breakage. A small triangular piece cut from the corner of each glass lid will save trouble in feeding.

9. When on an exploring excursion, whatever you discover living or growing in water that may be adaptable for your aquarium, take it home and try it. Oftentimes some pretty denizens are missed. Therefore nothing that may give variation should be discarded; it will be more or less instructive and will go to keep up the balance of nature. Variety gives the prettiest effect.

10. Food and how to feed are described elsewhere.

11. Feed about the same hour each day. Morning or evening is the best. It is Nature's time. Underfeed rather than overdo it. Remember most of aquaria trouble is the result of over-feeding.

12. Carnivorous and herbivorous fishes should not be kept in the same vessel. Do not keep small and large fish together, better to have them of a uniform size.

13. Sometimes you will notice the water has a milky or murky appearance; this is caused by feeding herbivorous fish too long on coffee biscuits, or may be due to a want of sufficient plant life to aerate the water.

14. Don't be too particular to remove all decaying vegetable matter; pond snails prefer such, they are the best scavengers you can have,

but remember you must have enough of them. Decaying vegetable matter eaten by the snails produces the organic soil that forms the plant food.

15. The water in an aquarium need never be changed; it will keep sweet and clean for an indefinite period if the balance of nature be maintained and the aquarium be in a suitable position, that is to say, it must have plenty of light, but no direct sun rays.

16. Cleanliness does not mean that there should be no leaf mould with the shell grit, but that the water, following nature, should be clear, or like that in a flowing stream.

17. All your plants should be subaqueous.

18. Don't keep crayfish with other animal specimens. They are always burrowing in the grit, &c., at the bottom of the aquaria, uprooting the plants and fouling the water.

19. Don't feed with uncooked flesh food. It makes the water impure. The fetid smell is offensive to those without the aquarium, and certain death to those within.

20. Don't feed herbivorous or other fish on bread.

21. When feeding with earthworms don't feed with large specimens. Gentles are the best animal food you can supply them with.

22. A supply of gentles can always be obtained by suspending a piece of flesh over a small vessel of bran; a sufficient supply will always be found in the bran.

23. On no account keep eels, big or little, in an aquarium; they will destroy all animal life therein.

24. Where goldfish and other carp are kept the water often becomes turbid; this is caused by the fish burrowing in the silt around the roots of the plants searching for nematoid worms. It is unsightly, but it does the fish no injury.

25. Gentles are the larvæ of blow-flies—the first stage after leaving the egg.

# Chapter XIV.

## HOLIDAYS AND VACATIONS.

No hobby can be indulged in without giving to it more or less personal attention. Nevertheless there are periods when such attention cannot be bestowed, and to delegate it to an uninterested outsider as a substitute is always fraught with failure. An aquarium should not absorb all one's leisure but serve as a pastime, and as such it is often essential that personal care be left in abeyance.

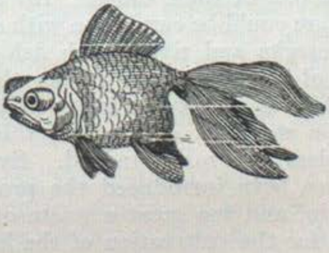
The inhabitants of aquaria may be classified as vegetable and animal. The former can always take care of themselves, because what sustenance they require is plentifully supplied by the decomposing organic matter that ought to be always permitted to accumulate at the bottom of an aquarium as plant-food. Not so with the animal life therein. Yet there are many of the smaller species of aquaria animals that are as capable of looking after themselves as are the specimens of plant-life; mollusca, crustacea, water-spiders, insects, rotifera, nematoid worms &c., can always find food enough to support life among the plants; indeed many of them live upon their fellows.

It is the larger specimens of fishes that must be cared for. If an aquarium be well stocked with a goodly supply of the smaller species of the animal life above named, the larger specimens need give you no anxiety. Indeed some of these will live without food for days, nay, for weeks. Goldfish and other vegetable feeders are well able to take care of themselves, if their home be well stocked with aquatic plants. If the carnivorous fishes have been well fed and are in a healthy condition, they too will survive a fairly long fast.

To supply fish, especially carnivorous fish, with enough food to suffice until your absence from them has expired, is a grave mistake. The food left unconsumed and permitted to remain in the water until the next day is the chief cause of mortality among fish. Indeed there can be nothing more detrimental than an over-supply of food. Food left in the water decomposes and generates foul and deleterious gases. These make the water impure, it becomes turbid, and from it fish cannot obtain pure oxygen, and they die from asphyxia. Unconsumed food, injurious and unsightly débris can easily be removed by the use of a suction pipe, as described in paragraph 7, Useful Hints.

In the case of fish that have been bred in aquaria, and thus domesticated, the laws of nature have been interfered with. Carp and other deep-swimming fishes, that is fish that swim near to the bottom of lakes, &c., hibernate when the water dries up; they have accessory breathing organs, by means of which they can breathe for a considerable time when out of water. There are varieties of fish that can live for days without water. These accessory organs are situated in the upper part of the gullet. Thus it is that carp and the like retain life longer than surface-swimming fish. It is well known that the climbing perch (*anabas scandens*) can live five or six days without a fresh supply of water.

Before going away on a holiday, prepare your aquarium for such an event. Everything within must be in a good state of health ; not overcrowded with fish life. A greater number of small fish can be supported in a fish tank than of those of larger size. Don't leave your aquarium in a position that is exposed to the full force of the noonday sun; permit daylight to enter the water through the surface only by covering the sides with a sheet of semi-opaque paper; if the aquarium is covered with a glass lid which can be opened, fill it with water to within a quarter of an inch of the cover, thus preventing evaporation as much as possible; the plants will supply all the necessary oxygen. A cover has many advantages; the water is kept cleaner by excluding dust; the fish are safe from the depredations of rats and cats, and from being disturbed by inquisitive observers.



# Chapter XV.

## ECONOMIC FISH FARMING.

Natural habitat—Natural Enemies—Food—Re-stocking—Fish Farming in Europe—Fish Farming in America.

Some time ago there appeared in the *Agricultural Gazette* an article on Bee Culture; the suggestion was made of mixed farming for farmers' wives and daughters. By this was meant the culture of berries, nuts, flowers, perfumes, &c. People in the Australian States pay little attention to farming as it is followed in Holland, Belgium, and other countries in the Old World, where peasants grow crops to support their own families, and sell the surplus. To supply the table with every-day necessaries, and even luxuries, grown and prepared by the members of the family, should be the first endeavour of all small landholders. It is said that Coleman, of mustard renown, made a fortune out of the quantity of mustard wasted by its consumers. Waste products are to be met with everywhere. If one sowing can be made to produce two crops so much the better for the producer. Crops that nature produces cost nothing for their cultivation. Animals that forage for themselves, and thus supply flesh food for the larder, are always valuable adjuncts to a man with a family. All holdings or farms are not adapted to the raising of every kind of crop necessary for a family. Fish is one of these crops. Yet there are hundreds of places where fish culture could be carried on with advantage. Hitherto, the stocking of our creeks and rivers with fish has conduced almost solely to the benefit of the sportsman, rather than purveying for the table. Fish, fresh fish, is a luxury, even on the seaboard of New South Wales. In the wayback districts of this State fresh fish on the table of the settlers is a rarity indeed. Even in those localities where exotic fish have been introduced the process of angling for a dinner is too uncertain, and too great a waste of time for men whose every hour is needed for the cultivation of the land. If fish could be raised so as to make available a meal with the same certainty and as little trouble as we can obtain a fowl from the poultry-yard, fish culture would become as common as poultry-keeping, or even more so. I admit there are great obstacles in the way; as there have been and are in every effort to introduce and produce foods that are uncommon, and surely fresh fish is an uncommon dish with the farming population of this State. Of course, the great drawback to fish culture in New South Wales is the aridity of the climate. But we are not always under the spell of drought. In normal seasons there is not a holding but has always water enough for the stock that is kept thereon.

Every waterhole where stock are watered could be so constructed as to be made suitable for fish culture. I know that what are considered the choicest table fish are chiefly found in running water or lakes that are constantly receiving fresh supplies of water. On the other hand, there are fish that thrive and multiply in stagnant waters, and such waters can be kept in condition favourable to fish-life by the introduction of aquatic plants. The conditions for keeping fish exist more or less on every homestead, because every homestead must have a supply of water other than for domestic use, *i.e.*, for watering stock. Fish in no way decrease the supply of water; they are in no way deleterious to water. Every waterhole should be a little world to itself. If it be not, it can be made so with little or no trouble. All weedless, stagnant waterholes breed corruption or deleterious gases. The remedy for this is to provide for a supply of oxygen to the water. It is well known that the carbonic acid given out by all animals—aquatic and otherwise—must be put out of the way so as not to injure the animals that have once exhaled it. The chief function of the vegetable world is to absorb this gas. The vegetable world in its turn throws off pure oxygen, which is essential to animal life. These marvellous principles of the adjustment of animal to vegetable life, and contrariwise, hold good over the whole of this terrestrial world, and when any spot becomes deprived of this balance of power by the absence of members of either of these two kingdoms of nature—vegetable and animal—the result is injury, sickness, or death. Thus it will be seen that plantless waterholes are always more or less unhealthy, but these unhealthy conditions can be adjusted. The influence of sunlight (waterholes as a rule always stand out in the open) on aquatic and terrestrial plants causes them to throw off this health-giving gas—oxygen. The water in these stagnant ponds, if stocked with water plants, will become more healthful to the animals that drink thereof.

While thus improving the drinking water of the stock we would, indirectly, be preparing to supply our table with palatable fish that would cost nothing after the first introduction. All fish are not suitable for stagnant water, that is, will not live therein, more particularly the *Salmonidæ*—the trout and salmon family. Some of the fish that have been introduced into this State are well adapted for the life here advocated. The English perch (*Perca fluviatilis*) is a well known fish in the Old Country, and will adapt itself to almost any surroundings.

It was introduced into this country many years ago, and at present it is very plentiful in certain waterholes around Queanbeyan, where it has multiplied greatly. The forefathers of these Queanbeyan fish were brought from Ballarat by Mr. John Gale many years since. There is no doubt that fish could now be obtained from the latter place for stock purposes.

All the perch family, of which there are many varieties, are well suited for pond culture. They are very prolific, and grow rapidly. They will survive out of water for many hours, and often, though apparently lifeless when returned to the water, speedily revive. In some countries it is the custom to take these fish to market alive, wrapped in wet weeds, and to expose them for sale for many hours. All the unsold fish are returned to the water none the worse for their transportation. Perch grow to a very fair size. In the waters around Birmingham (England), full grown fish run from 4 lb. to 6 lb., and occasional specimens have been taken weighing 8 lb.

The indigenous perch of this State, both the common and the golden, are splendid table fish, and will bear transportation well, and, I have no doubt, if cultivated in ponds, would succeed as well as the English perch.

Carp-like fishes (*Cyprinidæ*) are world-wide in their distribution, and some of the species are very delicate and toothsome, and prized highly for table purposes. In the ponds in England, I have seen them close on 2 feet long. In several parts of Europe carp are said to attain greater size and weight. Specimens have been taken from 3 feet to 4 feet in length, and weighing as much as 30 lb. and upwards. Especially is this the case in the artificial and natural fish ponds of Germany and Austria. In these countries a very great deal of attention has been bestowed upon pond-fish culture. The fish are fattened and sent to market like other farm stock.

It is as common in the countries mentioned for every farmer to have his carp-pond as it is for him to have his pigsty; and as much attention is paid to fish culture as to any other farm section. Indeed, from published accounts it would appear that from the large tracts of land devoted to fish culture, some of the farms are entirely devoted to fish farming. The Princess of Schwarzenberg, in Bohemia, has 22,000 acres, containing about 250 ponds devoted to carp culture, and sends 500,000 lb. of fish to market annually. Königswartha, in Upper Lusatia, has 9,000 acres, containing 205 ponds. There is another farm at Peitz-Cottbus, Brandenburg, with 72 ponds, covering 5,600 acres; and wherever there is a farm there is a fish pond to supply the owner's own table with fish, as we in this country raise poultry for the table.

The carp family is an extensive one, and there are many varieties of the family, suitable for pond purposes. Some are more ornamental than useful. Our beautiful goldfish are members of the family, and contain numerous varieties most beautiful in colour, and quaint in form. The beautiful fantail and fringetail Japanese goldfish, supposed to be a modern innovation or sport perpetuated by the Japanese for ornamental purposes, has been known for nearly 200 years by pisciculturists. The common goldfish, or the Golden carp (*Carassius auratus*) were early introduced into Australia, but they are coarse and bony. These fish were at first introduced for aquarium purposes, but are now met with in nearly all our rivers. Around about Sydney, wherever there are a few hundred gallons of permanent water, there the goldfish are to be found; but their attractive colour has disappeared. These escaped fish have degenerated into a brownish bronze-green, the colour of the common carp (*Carassius vulgaris*), the colour all goldfish are for the first few months of their life. The *Carassius auratus* take to confinement well. They are very prolific, and will breed almost under any conditions. To dwellers in the way-back country I would say, cultivate these carp. They will grow, under favourable conditions, to 12 inches or 18 inches long, and weigh from 2 lb. to 4 lb.—not a bad fish for the table when you cannot get anything better.

There are many other varieties of carp that will thrive well in the waterholes and dams in the interior of this State—the king carp, the naked carp, and the blue carp. In some parts of Europe the last is prized above the scale or noble carp.

The scale, noble, or king carp (for in different localities it has various names), appears to be indigenous to the still waters of the European continent. On account of its value as an article of diet it has been largely distributed and cultivated. It is not known when the carp was introduced into England. "Turkeys, carp, and beer, all came to England in one year," is an old doggerel, read in my schoolboy days. I do not think there is much truth in the statement, still it goes to show that the exact date of its introduction into the old land is unknown.

American farmers have of late been successful breeders of some of the most useful and delicate-fleshed carp. In 1876, one of the Fish Commissioners, Mr. T. F. Blair, imported several varieties of these fish under review, and distributed them among the farmers of the country. Some four or five years prior to this, a German, Mr. J. A. Poppe, had sent from Holstein eighty-three fish; only five of these, about 3 inches long, reached the end of their journey, but they bred so rapidly that in a few years the ponds of the farmers of the United States were fairly well stocked.

There are now at Washington what are called the national carp ponds, where carp are reared and distributed free of charge, as is done with the trout raised at Prospect in this State; but there is this difference, the carp are distributed among the American farmers as a food supply, and not for the pleasure of a few sportsmen.

As a rule, most of the fish of the colder zones when transported to warmer regions do not grow so large as in their native habitat; but carp appear to adapt themselves to any climate, and are well suited for the warmer districts of this State. Not only so, but water wherein there is thriving plant-life has a temperature many degrees lower than water destitute of it.

The benefits derived from the culture of fish must not be confined to one idea, that is, to the procuring of a toothsome luxury for a meal table. That in itself is worth the taking of the initiatory steps, for, if nature has supplied the necessary conditions in any locality for the propagation of fishes, but has withheld the all-important adjunct fish, there is little more to be done than to supply the deficiency. Apart from the domestic supply to be obtained, there are other advantages that it is as well here to enumerate. Of course, angling for a breakfast in the early morning will suggest itself. Young people are always more or less keen on such a pleasure as that of trying to catch fish, especially so when it is known there are fish waiting to be caught. It is well known that in many districts one of the plagues of life is the intolerable nuisance occasioned by the attack of mosquitoes. These troublesome insects form their boats of eggs, and moor them to a weed or other floating object. The larvæ hatched are denizens of water. Stagnant water is their especial haunt. Mosquitoes have no choice as regards the quantity of water necessary for them to breed in. A bucketful left standing for a day or so will be sure to attract them; 400-gallon iron tanks literally swarm with them. Oftentimes the only way to get into these tanks for breeding purposes is by means of the down-pipe. An open waterhole is a perfect paradise for them. Put a few fish of any variety in places where the mosquitoes breed, and they will soon make a meal of the larvæ. There is nothing better for the rearing of young fish than mosquito larvæ. Thus fish purify the water by preventing the decomposition of the chrysalis case of the various insects that pass one stage of their metamorphoses in water.

I have said elsewhere that it is imperatively necessary that there should be a good supply of aquatic plants in every waterhole where fish are to be kept, and also where they are not kept. These, in varieties, can be obtained in any of our fresh-water creeks and lagoons. When once these plants establish themselves they are likely sometimes to make too much headway, nevertheless their exuberant growth aids much in preserving the water both in quality and quantity. Plants that float on the surface of the water keep the water cool.

Again, in summer time, in waterholes it will be noted that an impalpable green, mossy-looking substance (Confervæ) becomes very abundant. This growth and the growth of aquatic plants generally can be kept fairly well in check by the introduction of shellfish. In many of our creeks, waterholes, and rivers there are to be met with large quantities of molluscs (pond snails and limpets). These water snails grow to about an inch long. They are wonderfully prolific. From the Hunter River I have picked the young ones up by the handful. These are the scavengers for fresh water, and at the same time they serve as a food for the fish. There are other kinds of shellfish to be met with, notably varieties of mussels; these are all more or less useful in fish-culture. I have seen fully a dozen of them devouring the carcase of a small dead fish, but never once have I seen them on the body of a healthy one.

There are many aquatic insects, or rather insects that are aquatic in some stages of their transformation. Many of them are fish enemies, notably dragon-flies, which feed on the young and helpless fry, but these in their turn become food for the adult fish. Where there is water these insects abound. From the early dawn to the gloaming they can be seen skimming over the water like so many swallows. During the day they are chiefly engaged in depositing their eggs. In the evening they seem to be chiefly concerned in hawking for mosquitoes. On the northern rivers of this State they are more commonly termed mosquito hawks than dragon-flies. These insects, whilst in the larval state, feed largely on the larvæ of other insects, and also on young helpless fish.

Therefore, in the early period of establishing or entering into the culture of fresh-water fish, these facts should not be overlooked. It may be found necessary at the outset to resort to artificial culture, *i.e.*, to breed fish away from their enemies, or near at home where they can be more or less watched and protected from the enemies named. There is nothing in the artificial rearing of fish for stocking fish-ponds or waterholes to dismay anyone. A schoolboy can manage it. The chief secret of success is protection from enemies.

Waterfowl, both wild and domesticated, should be kept away from fish-ponds. They do little or no harm to grown fish, beyond disturbing them during the breeding season, but fry are very dainty morsels to their palate. Those birds that live on fish, such as shags and cormorants, will catch and devour fish of almost any size. The gun should always be levelled against them.

Frogs when small and in the tadpole state form excellent food for fish. Tadpoles feed on vegetable food, and, therefore, should be encouraged rather than destroyed, notwithstanding that the author of the "Compleat Angler"—Walton—seriously affirmed "that frogs do lay their eggs round the necks of fishes, and thereby strangle them."

There are many diseases that fish are heir to. These are chiefly brought on by overcrowding, and thereby an insufficiency of food. These diseases chiefly appear when fish are kept in tanks, although an epidemic will sometimes occur where fish have every advantage of food and freedom that Nature can give.

All animals are more or less attacked by parasites, and fish are no exception, but I think salt-water fish are more liable to be attacked by parasites than those of fresh water. I have noticed these parasites among my own fish kept in glass aquaria. When the fish are swimming near the glass sides, with the aid of an ordinary lens I have noticed parasites clinging to the scales underneath the pectoral fins. Of course, most of my aquaria fish are small. By putting a tablespoonful of salt in a medium size basin of water I have generally succeeded in removing these too neighbourly neighbours.

The object to be attained in this artificial culture is, that it should approximate as nearly as possible to natural conditions. The water, therefore, should be stocked with inhabitants both vegetable and animal, obtained as far as possible from local rivers and waterholes. Care should be taken to avoid the introduction of known fish enemies.

# Chapter XVI.

## THE CULTURE OF FRESH-WATER FISHES.

### Profitable culture—Fresh-water Mullet.

There are certain classes of fish of which some varieties live in salt water, others in brackish water, and others again in purely fresh water. Among fresh-water fishes, some varieties will live only in running waters and others in stagnant or still waters. Some fish spend portion of their life in salt water and the other portion in fresh water—a constant migration from salt seas to fresh-water rivers.

The rapid mountain torrents which some fish revel in would be death to those whose habitat is the stagnant water of weedy ponds and contrariwise.

Amongst our indigenous fishes that thrive and multiply very rapidly is the Murray cod. These are to be met with in all the rivers of the west and their tributaries. The late Mr. Wilcox, of Grafton, who was an excellent authority on the subject, once informed me that the Murray cod was to be met with in the waters of the Upper Clarence. These were not exactly of the same variety as those of the Murray. Several times I have fished the tributaries in the upper portion of the watershed of that river, but failed to obtain a specimen.

The Murray cod bears transportation well, and will soon adapt itself to its new home. Many years ago the late Sir Terence Aubrey Murray introduced this fish from the tributaries of the Queanbeyan River to Lake George. In a few years the lake and creeks emptying themselves therein, were fairly well stocked with cod. The people living near this lake soon had their larders well stored with these fish, which was a welcome change from the everlasting mutton. From Lake George some of the descendants of the fish that were introduced there were carried to the waters of the Wollondilly River and the Mulwarree Ponds near Goulburn. The Wollondilly River is the name given to the upper portion of the Hawkesbury River, and there is nothing, therefore, to prevent the Murray cod from becoming an inhabitant of the fresh waters of the last-named river and its tributaries. Amongst other fish, and indeed among themselves, cod are very destructive, greedily devouring any fish that comes in their way. Nevertheless, nearly all kinds of fish are equally destructive. The life of all fish seems to be one of hide and seek.

One of the most toothsome of Australian fresh-water fishes is undoubtedly the golden perch. It is common in all rivers and waterholes and swamps that are intersected by deep water. It is a very beautiful fish; the general colour of the back is a bright green, the sides are a rich golden yellow, the head, when the fish is in season, has all the colours of the rainbow. In some specimens, the belly is white, in others it is red. The pupil of the eye is purple surrounded by a white ring. These colours only appear in the adult fish; the young are far more sombre in colour. For stocking ponds these fish, being natives, are equal if not superior to any that could be imported. The flesh is white, delicate, and of good flavour, and in weight they run to about 7 lb.

Of the silver bream, sometimes called the silver perch (*Therapon bidyana*), the Rev. J. E. Tenison-Woods says, "This is the perfection of fresh-water fishes, extremely rich and delicate in flavour." In weight they run to about 5 lb. or 6 lb. They prefer running water in which to dwell. In the interior during dry seasons, when the rivers and creeks become chains of ponds and billabongs, these fish are found to be as healthy and in as good condition as the golden perch, and it is highly probable they would submit to pond culture equally with their golden brethren. They are found in all the tributaries of the Murray.

The perch of the old colonists is of a silver grey colour, darker on the back, and turning to white on the belly. This, the common perch, is to be met with at the head and in the tributaries of all the rivers in the Eastern Slope of the Great Dividing Range. On the Western Slope, in the watershed of the River Murray, is a fish very similar, known to scientists as Macquarie's perch. Both of these are catalogued among edible fishes, and afford excellent sport for fishermen who dwell in proximity to these rivers. When hooked they fight for freedom and dispute every inch over which they are hauled. They love deep holes where it is quiet and shady. In some of our freshwater creeks that are covered over with aquatic weeds, there is here and there an opening, or, as it is sometimes termed, a breathing-hole. In these holes the largest perch are to be found, and a black cricket dropped into such a place is sure to attract the largest fish in it. These common perch are not particular as to the waters they frequent. I have caught them in the saltwater estuary of the Clarence River as well as in the brackish and fresh water higher up towards the head. I have caught them from 4 lb. to 6 lb. After a flood they are to be met with in the shallow waters, where they have been left behind, and there they remain till the waters dry up. From such places enough small fish could be taken to stock any sheet of water required.

### MULLET.

In the waterholes in and about Marrickville (Sydney), which have been made by the removal of clay for brick-making, there are large numbers of fresh-water mullet that have been carried there when the flats have been flooded. In these holes the fish thrive and multiply. Speaking of these fish, J. Douglas Ogilby says:—"Few, if any, fishes can be more easily domesticated than those belonging to the *Mullidæ* (mullet family). . . . Their hardiness, their adaptability to the various conditions of life, their indifference to the density of the element which they inhabit, the fact which has been proved that they breed and thrive equally well in enclosed *fresh*-water ponds as under normal conditions, the ease with which they may be brought to perfection at a minimum of cost, since no artificial method of supplying food would be required, all point to our grey mullet as the pioneer of a fishing industry." If all this be true, there is surely no better fish for the purpose for which I write than this grey mullet. If such fishes as the varieties of perches and mullet can be had with so little trouble, why advocate the introduction of foreign fishes into our waters?

### THE GOURAMI.

The Gourami is a foreigner, and is said to be one of the best flavoured fresh-water fish in the East Indian Archipelago. It is a native of Java, Borneo, &c. It has been successfully carried to Mauritius and to South America. Therefore, there would not be much trouble to introduce it into New South Wales. The family of fish to which the Gourami belongs appears to have been designed by nature for the purpose of being transported from country to country.

"They have a kind of supernumerary gill in a cavity to itself which enables the fish to live for some time out of water. In the accessory bronchial cavity there is lodged a laminated organ which evidently has the function of assisting in the oxygenisation of the blood. This accounts for the ease with which some can be acclimatised and transferred from pond to pond." The Gourami, when full grown, weighs from 8 lb. to 10 lb.

# Chapter XVII.

## COMMERCIAL VALUE OF FISH FARMING.

The culture of fresh-water fishes as an industry is now carried on in America, England, and other European countries, giving employment to numerous families. The profits derived from the employment of this labour and the cultivation of these fresh-water finny tribes are equal to those of many other industries that are carried on solely for commercial purposes.

In England and on the continent of Europe during the great season for eating fish—Lent—the profits arising from the sale of this product, more especially the members of the great carp family, are very great. The following is an extract, I think, from the London *Daily Telegraph*, which affords some idea as to the value of "farmed" fish :—"The first prosecution under the new Act (an Act for the prevention of cruelty to wild animals in captivity) took place on Monday, when an Oxford-street fishmonger and his assistants were fined for cruelty to Prussian carp, which were sold *alive* to Jews and Germans at Christmas time for 2d. apiece. Into a tank 33 in. long and 15 in. wide, containing a depth of 7½ in. of water, were squeezed 700 of the fish referred to, each from 4 in. to 6 in. long." The retail value, then, of these fish was nearly £6.

The *Standard*, in 1884, reporting on the Fisheries Exhibition, gives an account of a very large establishment for fish culture, involving a capital of about £12,000; this outlay was expected to yield a profit of something like 20 per cent. In this case the purpose of fish culture was more for the restocking of rivers and other watercourses for sporting purposes. The prices asked and obtained for the fish were a good deal higher than would have been the case in ordinary commerce.

Artificial fish-breeding was at first confined to the Salmonidæ family, and was inaugurated about the middle of last century by Mr. Frank Buckland. The Sunbury breeding ponds were established for the purpose of restoring the river Thames and its tributaries to their former status as trout and salmon streams.

The river Tay and its tributaries had been equally decimated of finny inhabitants, chiefly fish of the Salmonidæ tribe, by the same means as in the case of the Thames. To restock this river and its tributaries, hatcheries and breeding ponds were established at Stormontfield. These two rivers, the Thames and the Tay, had been in the past notorious as localities for enjoyment of the ever-exciting pleasure of angling for trout and salmon. At that time the idea of general fish-farming was not entered upon, notwithstanding that the Romans carried it on successfully. A fish farm, where fish could be obtained in all stages, from the ova to the marketable article, is comparatively of very recent date. The Fisheries Exhibition report already referred to gives detailed description of the "Howietoun system" of fish farming. Howietoun commenced working upon his system about the year 1870 with about 50 spawning fishes. Ten years later his stock of breeding fish amounted to no less than 40,000 and the eyed ova, *i.e.*, fish eggs that are known to be fertile, were about 6,000,000 per annum; and that did not include some 500,000 fry annually produced on the farm. The greater portion of these 500,000 fry are held over until they are yearlings and are then sold for the stocking of suitable waters. Some clue to the profits of fish culture may be gathered from the prices given for "partially-eyed" ova of the various varieties and species of the Salmonidæ produced at the fish farm under review. In passing, I may mention that only varieties of trout and salmon were experimented with, but if the same system be adopted with other fish the results will be equally successful, although the profits may not be so large, on account of the fish not being so valuable for table purposes. The following were the prices obtained for the partially-eyed ova per 100,000:—*Fontinales* £60, *Levenensis* and *Fario* £45 for the same quantity. These were net prices, and did not include the cost of transport and personal attendance to the place of destination. The price of ova rises inversely to the quantity required, thus the price of 10,000 is 10 per cent. higher, and the price of 1,000 rises 50 per cent. above this. *Fontinales* (Char) and *Levenensis* (the Loch Leven Trout) or *Fario* (Brown Trout) are each £5 for 5,000; smaller quantities are double the price. The older the fish the greater the rise in price; yearling *Fontinales* are £10 per 1,000, but two-year-old fish are *ten times* as expensive, *i.e.*, £100 per 1,000. Of course, these are only for restocking waters denuded of fish. No one but a Rothschild or a Carnegie could obtain a dinner of fish at such a cost as this.

The foregoing results of fish farming have only to do with conditions and experiments conducted upon the most elaborate and scientific principles. Indeed, the whole system is an artificial production of fish for the purpose of assisting Nature to replenish her waters whence man, for the purposes of food or sport, has "eaten the hen that laid the golden egg." The fish that have been most experimented with are those of the choicest species or those that conduce to the greatest amount of excitement to the sportsman. "What man has done man can do," is an old aphorism that is very applicable to experimenting with the higher classes of fish referred to, and fish of a hardier nature when thus experimented with, would be equally, if not more, successful. Carp-like fish are more adaptable to ponds or stagnant waters than the trout-like fish. By carp-like fishes I do not mean the degenerate goldfish (*Carassius auratus*), but the king carp, noble carp, the green and golden tench, &c. Some of the members of this great family grow from 3 to 4 feet in length, and weigh between 20 lb. and 40 lb. When once these fish are placed in suitable waters there is no further expense; Nature will do all that is required. At present the commonest sea or salt-water fish exposed for sale and sold by weight here in Sydney fetch 4d. per pound, and the choicer kinds double that price. A pond, if there be no natural waterhole, will pay for its construction and maintenance and the fish cultivated therein will be a valuable asset. There is no reason why these 30 lb. and 40 lb. fish cannot be produced in these States as is the case in Europe and America. Some of these fish, from a commercial point of view, would be worth at least 30s. per cwt.

No animals are more prolific than fish. Nature appears to have ordained that food fishes should be pre-eminently so. Amongst marine fishes the Newfoundland cod (*Gadus morrhua*) is a well-known example. In the fishing season this fish gives employment to thousands and a food-supply to tens of thousands. The eggs produced by a single cod-fish are estimated at the enormous number of 6,652,000, *i.e.*, a cod-fish weighing 21½ lb., and measuring 38 inches long, and this is by no means an abnormal weight or length for a Newfoundland cod-fish; and a herring less than a foot in length (11½ inches) is said to contain no fewer than 4,700,000 ova. But then these are salt-water fishes, and marine fish are always far more prolific than those that inhabit fresh water. An ordinary carp weighing 9 lb. contains 600,000 eggs, whereas a cod of the species referred to and of the same weight (9 lb.) would contain twice that quantity. A 4 lb. tench will deposit at one spawning about 297,000 eggs, and a small English perch (weighing only 1½ lb.) is capable of being, in the course of a few days, the mother of no less than 280,000 "children." As to the salmon and the trout, two of the most delicate-fleshed fish that swim, 1 lb. of roe of the first-named contains 900 eggs, and a pound of the roe of the last-named 800 eggs. I have seen the roes of some of our native fishes, the Murray cod (*Oligorus macquariensis*), and some varieties of our fresh-water perch (*Percalates colonorum*), that must have contained some hundreds of thousands of eggs.

Notwithstanding the very great number of eggs deposited during the breeding season of any variety of fish, when in a state of nature, a very small percentage come to maturity on account of the numerous enemies that fish-flesh is heir to. In our rivers and lakes no sooner are the eggs deposited than they become the prey of aquatic creatures, and, of course, eggs have no chance to elude their enemies. The young fish, when pursued, rush into the shallow water and take shelter among the weeds that fringe the banks. I think all fishes, almost without exception, are cannibals. I have seen amongst my own aquaria fish the non-spawners intermingling with the spawners, catching and devouring the spawn as it extrudes. Further, I have seen both the male and female that have been engaged in the duty of reproduction, as soon as that interesting work is accomplished, search for their own eggs and greedily devour them. To compensate in some way for the state of things here narrated, Nature has designed that the period during which the eggs are developing to maturity shall be short. The time that elapses before the eggs hatch is seldom more than six days, and when the weather is warm I have known the young fish to appear in from seventy to seventy-five hours. These are the periods in some of the carp family. I have seen eggs of my Paradise fish (*Macropodus venustus*) mature in thirty-six to forty hours.

When fish life begins fish troubles begin. Young fish no sooner escape from their imprisonment in the egg than they find that their enemies have increased rather than diminished, and their chance of escape is little or no better than it was during the egg period. During the first few days of their existence the young fish are almost motionless, and so they remain until the absorption of the yolk-sac. As the young fish grow, so their powers of locomotion increase, and then they are somewhat relieved from the pressure of their enemies.

I said just now that carp are cannibals. Not only do the old fish devour their own eggs and offspring, but I have seen the young of these fish, when not more than ¾ inch long, catch and devour their smaller and weaker brothers and sisters. Indeed, I have seen the bai nearly as big as the biter. When fish are living in a state of nature it seems almost a miracle that so many of them come to maturity. If the large number of eggs of the perch, tench, and carp that I have referred to (and these are the fish best suited for pond culture) were all fertile and the young fish came to maturity, a very few stock or breeding fishes would be enough to produce fish-food for a whole district. With the numerous enemies that fish are surrounded with—enemies in the air, enemies in the water, and enemies on the land—the wonder is that defenceless fish are not more frequently exterminated. In a state of nature fish increase rapidly where the best conditions exist for their preservation—*i.e.*, where there are long stretches of water entirely free from weeds, these alternating with shallows containing dense masses of aquatic herbage. In some of our inland fresh-water rivers and creeks the places where there is open water surrounded by weeds are always the favourite breeding grounds for their finny inhabitants. Such spots act at once as good spawning grounds and give ample protection for the young fish when hatched. Fresh-water fishes either spawn in or on the gravel or sandy bottoms of their habitat or amongst the weeds. Few, if any, spawn on the surface of the water, as is the case with some of our marine fish. Weeds are the favourite breeding grounds for the carp family. The eggs of these fish when extruded are soft and covered with an adhesive gelatinous substance. The first object touched by these eggs after extrusion is adhered to, and the adhesive matter surrounding them quickly hardens, and in this way the eggs find additional protection. While the eggs are in the act of being fertilised the water is in constant motion caused by the agitation of the fish. This motion given to the water by the fish scatters the eggs broadcast amongst the weeds. Carp always come to the surface to spawn. The spawn is extruded by sudden jerks. I have seen it, when the fish have been greatly agitated, thrown free from the water and adhere to the sides of my aquarium. The whole of the eggs in the ovary or roe of a carp, as previously noted, are not extruded at one time. The process of spawning continues for hours; indeed, I have known it carried into the second day. With each spasmodic motion of the fish from 6 to 100 eggs are extruded. Thus it will be seen that aquatic plants, or an equivalent, are a necessary adjunct to the breeding grounds of these fish. All rivers and waterholes or ponds have their beds on more or less of an inclined plane, and, as a rule, the largest fish tenant the deepest waters, and the smallest fry are found nearest the margins of the shores. The reason for the small fish inhabiting these localities is not far to seek. They are constantly being pursued by the larger fish, and shoal waters are therefore protective to the smaller fish; but, when driven into shallow water, they at once become a prey to their terrestrial enemies; these latter they elude by concealment.

The foregoing gives in brief the conditions required by fish for the purposes of reproduction. Inspection of a natural breeding ground will give anyone an idea for the construction of an artificial breeding site for fish. All artificial waterholes are constructed upon this plan—*i.e.*, shallow margins and deepening towards the centre. It is quite natural that it should be so. The approaches to a waterhole are always so constructed to give easy access. The shoaling of the water towards its margins is a favourable condition for the propagation of fish, and this is to be met with in every drinking hole for stock. The only other necessary adjunct is the supply of suitable aquatic plants. Any plant that will live and thrive in water is suitable for that purpose, but of course there are some more suitable than others.

The propagation of fish in their natural habitat is surrounded with many dangers. The hundreds of thousand of eggs produced by each spawner and the few fish that come to maturity is sufficient evidence in proof thereof, and the more the spawn and young fish are protected the better will be the results. Given a waterhole, deepening towards the centre, the margins thereof planted with water plants that have become fairly well established, a dozen or even less fish of a chosen variety introduced would supply anyone's table with a fair amount of fish for food purposes.

Many animals improve under the fostering hand of man. Even Nature can be greatly assisted by protective conditions and the destruction of natural enemies. Fish placed in a pond having the conditions named would thrive and multiply therein if left entirely alone to their own sweet will.

No one will dispute the fact that domestication not only improves the quality but the size of animals. Domestication also increases the demand, and demand in its turn tends to increasing numbers. Although fish will naturally increase in numbers if treated as before described, there may be conditions in which it may be necessary to resort to artificial aids to re-stock ponds which have become more or less exhausted. Insufficiency of size or shelter and protection will contribute largely towards exhausting the domestic supply of fish.

If the weed-growth be insufficient for protective purposes, bundles of brushwood sunk at intervals in the pond will answer the purpose well, but we must bear in mind they supply no food. To enable these bundles of brushwood to become a source of food to the young fish it would be necessary for the brushwood to be in the water a sufficiently long time for the spores of some one or other of the fresh-water *algæ* to have started into growth thereon. That sheen-like moss met with on stones and other objects in waterholes forms a grand grazing ground for carp, more especially for the younger members of the family. In my own aquaria I have often watched the young fish when not half an inch long feeding ravenously thereon.

Then, again, artificial means may be adopted for collecting the spawn that has been deposited in the ponds or other waters. You will remember the great destruction the spawn is subject to from the period of its extrusion until it hatches, the exciting times the young fry have to retain their little lives, and the few there be that pull through babyhood. As a rule, the carp family delight to commence spawning in the early morning, just as the sun comes glinting on the surface of the water, and continue until about noon, but I have known them to continue till sundown and even after. They generally select the sunny side of the water where the weeds are thickest. In breeding seasons and on the approach of the spawning period the sexes will be seen chasing each other hither and thither, the males constantly trying to chase the females that are in the weeds to the surface of the water. When once there the fish will be seen rolling and tumbling one over the other, the milters constantly forcing the spawners upwards. Then there will be a splash, and the fish will be seen darting away in all directions to renew the same tactics again a few minutes hence. The moment the splash I have referred to is seen that is the time that the extrusion of the eggs from the spawner takes place and also of the milt from the milter. Fish eggs are fertilised *after* extrusion. These eggs then gradually sink through the water and adhere to every object they come in contact with.

If, then, the ponds are found to be deficient in weeds, these may be obtained from elsewhere. Pull them up by the roots. Wash well both the roots and the foliage, tying them in loose bunches and deposit them in the water, so that they may float on the sunny side of the fish pond in early spring when the fish are seen playing about as described.

If tubs or other vessels be filled with water from the pond in which the fish have spawned, in order that the eggs may retain the same temperature, and the weeds in which the fish have spawned placed therein, in a few days hundreds of tiny fish will be seen hanging to the weeds. Don't disturb them. In a short time they will be darting about in the water. They grow rapidly and when sufficiently grown they may be returned to the waterhole, but be sure you have provided sufficient cover for their protection from enemies.

I have hatched hundreds of carp in quart bottles. It is interesting to watch the eggs developing. In a little more than forty-eight hours, according to the temperature, two little black spots will be seen to put in an appearance in each fertile egg. This change in the egg is termed "eyeing." The spots become more pronounced as the egg approaches maturity. Just as the egg is about to hatch there will be a little quivering motion, the semi-opaque covering of the egg will open, the tiny inhabitant emerge, stretch itself, hang up close to the discarded egg-shell, tail downwards, expand its tiny gill covers and take its first draught of oxygen. I have sat and watched for hours the little fish forcing their way out of their prison. It is an interesting sight. At the time they emerge from the egg they are almost transparent. Who would ever think that these little fragile creatures would grow sufficiently large to be a meal for a fairly numerous family? Yet it is so.

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